The FOUNDRY

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Castings Aid in Securing Even Coating of Paint

THE smooth, even and lustrous coating of paint, which adds beauty to the automobile, kitchen stove and pieces of furniture, to say nothing of hundreds of other objects in everyday use, probably was secured

Castings Are Used in the Spray Gun

by applying the paint or enamel with a spray gun. That tool, one of many using compressed air as a source of power, has found increasing favor in recent years, and has influenced to a large extent the amount of work necessary in painting, enameling and lacquering large or small surfaces. While the spraying method often is used in paintings buildings, structural steel in bridges and other types of structures, in the main, the process of covering surfaces has been adopted in industries where it is essential to speed production to a high point. The foundry industry again renders service by making the spray gun possible, for castings, usually made of an aluminum alloy, are employed in the important parts of the spraying machine. In fact it is difficult to find an industrial operation which does not receive aid from foundry products.

Find Where Castings Can Be Sold

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Tech 25

Federal Reserve Bank Utilizes Cast

METAL, much of it in the form of castings, is being used extensively to decorate the beautiful new Federal Reserve Bank building, now under construction at Pittsburgh. The new structure, which is being erected at a cost, with equipment, of approximately $1,300,000, is located on Grant street and Ogle way. The ground floor will measure 75 x 195 feet, and the design includes three set backs.

Many of the decorative features of the building were cast in aluminum and monel metal by the John Harsch Bronze & Foundry Co., 11612 Madison avenue, Cleveland. Approximately 6 tons of art castings have been executed in monel metal for the Pittsburgh bank building. In many instances, due to the size and complicated design, it has been necessary to cast a section in several pieces, later assembling the various pieces with the aid of electric or acetylene welding. The thickness of metal on the majority of these castings is 3/16 of an inch.

Metal used for making these castings conforms to the following specifications: Nickel, 67 per cent; copper, 28 per cent; iron, under 3.5 per cent; silicon, 0.75 to 2.0 per cent; carbon, 0.15 to 0.25 per cent; manganese, under 0.50 per cent; and sulphur, as low as possible. Since the metal must be melted and poured at high temperatures, approaching those of steel, and also due to the fact that the metal absorbs gases during the melting period, the use of an open, refractory molding sand is required. The mixture used in the Harsch foundry consists of equal parts of sharp, Michigan lake and No. 2 Albany sand and a cereal binder in the ratio of 35 parts sand to 1 of the binder, added dry.

In general molds for casting monel metal are rammed in the same manner as those for bronze castings. Gates are made slightly heavier than in bronze and the castings are risered well. Size and distribution of the risers and gates follows closely steel foundry practice for the metal chills rapidly. Special precautions are taken to see that risers are large enough and that they feed metal into the casting instead of drawing it out. Molds for the heavier architectural castings are sprayed with molasses water, faced with graphite and skin-dried. They also are gaggered well to hold the sand in place, and the copes are equipped with bars 6 inches apart, which extend to within ¾-inch of the mold face.

Small castings weighing from 1 to 5 pounds are molded in green sand. The sand mixture for these is the same as used on heavier castings, with the exception that the binder omitted from the mix. Heavy castings are gated from the bottom, usually with a horn gate.

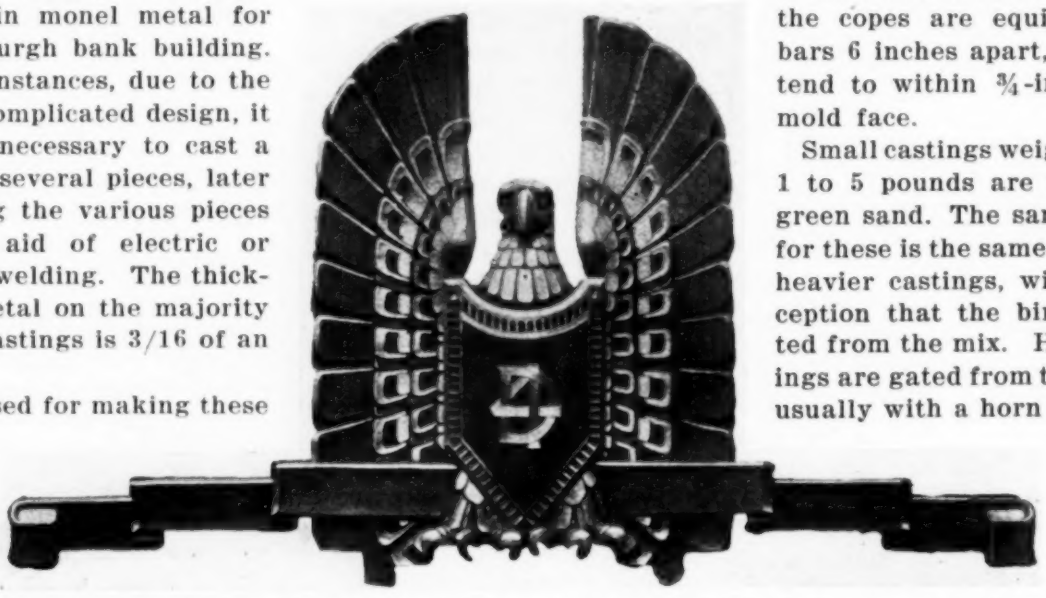


Fig. 1—A Cast Aluminum Eagle 10 Feet High and 20 Feet Wide, Will Be Located on the Front of the Building

Metal is melted in No. 70 silicon carbide crucibles in gas-fired, pit furnaces, only ingot metal being used. The crucible first is placed in the furnace and then is filled with ingots. When the first charge of ingots is melted, others are added until the required amount of metal is in the crucible. Glass is used as a covering for the metal, which is heated to approximately 3000 degrees Fahr. before the crucible is withdrawn from the furnace. Small amounts of magnesium and ferrosilicon are used as deoxidizers.

Furnaces used to melt the metal are gas-fired at a pressure of 35 pounds per square inch. Ap-

# of Pittsburgh Architectural Decorations

By Norman F. Hindle

proximately 2 hours are required for the metal to reach the desired temperature after the charge has been placed in the crucible.

The average life of the crucibles is six heats. When it is considered that the metal is melted and poured at temperatures approaching those of low carbon cast steel, the need for satisfactory crucibles is evident. The John Harsch Bronze & Foundry company metal losses in handling monel metal does not exceed 10 per cent. That figure includes scrap castings, spilled metal, melting losses, etc.

Fig. 2—Mold for Architectural Casting Showing Method of Gating and Risering

When the metal has reached the desired temperature in the furnace, the crucible is lifted from the pit with a lifting attachment and is carried to the molds. Pouring temperatures at the mold depend on the size of the casting. Thin architectural castings, such as those shown in the accompanying illustration, are poured at temperatures ranging from 2800 to 2900 degrees Fahr. Larger castings are poured at temperatures as low as 2500 degrees Fahr. Each molder, with the help of others in the shop, pours his own molds.

After the pot has been pulled from the furnace, the charge is divided among two or more empty, hot pots, depending upon the number of sprues in the mold, and then is carried to the respective molds as quickly as possible. Pots generally are held a few seconds to be sure that all pots of metal are at the same temperature and then the metal is poured as fast as the mold will take it. Quick handling and high temperature are two important factors in securing good castings.

As soon as the metal in the mold has solidified, the casting is shaken out, generally at a red heat to prevent cracking, as the metal is extremely tender slightly below its solidification point and also has a large shrinkage, ¼-inch per foot. On long, thin castings, such as those shown in Fig. 6, gates are knocked off, also a preventative measure against cracking. No danger to the casting is involved in removing the gate from the mold, while the casting is at a red heat, and failure to do so

Fig. 3—Metal Must Be Poured at High Temperatures and Must Be Handled Quickly

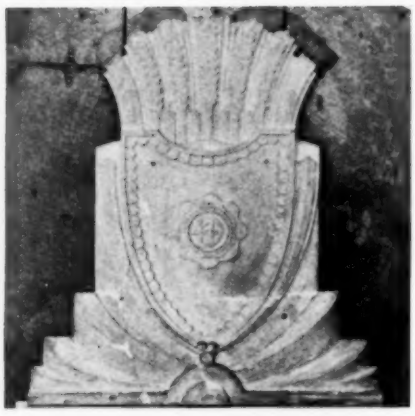


Fig. 4—Plaster Pattern Used in the Mold Shown in Fig. 2

may result in a badly cracked casting.

Cores for monel metal castings are made of the same sand mixture as the molds. That mixture fulfills the requirements of cores for that type work, since they must be soft and collapsible but must not crumble or burn when the metal strikes them. Wire, ¼-inch in diameter, is used to stiffen the cores. Stiffness is essential in cores of the type used in the casting shown in Fig. 7, which is 1-inch square and 6 feet long with a 3/16-inch metal thickness.

Cleaning Costs Higher

Cleaning costs for monel metal castings amount to approximately twice those of bronze. Although the sand peels from the casting well, as is shown in the photograph reproduced as Fig. 5, which was taken shortly after the casting had been shaken out, the toughness of the metal and the high luster demanded increase the cleaning cost. After the castings are shaken from the mold and have cooled, they are sandblasted. Gates that were not knocked off at the shakeout are removed with a silicon carbide cutting wheel ⅛ x 14 inches. Following those operations the castings are polished and buffed.

A department is maintained at the John Harsch company for the assembling of castings when a job is made in several pieces. Monel metal assemblies are made by either electric or acetylene welding depending on the type most suitable for a given purpose.

Molding of monel metal castings is an exceedingly interesting process. Take for example, the casting in Fig. 5 with the gates and risers attached, the pattern for which is shown in Fig. 4. That is an ornamental casting and the pattern, as generally is the practice in such cases, is made of plaster. Wooden flasks are used throughout the shop.

In making the mold, the drag section is made first. The pattern, mounted on its follow board, is placed on the floor and some sand riddled over it. Sand along the sides is removed and the drag section of the flask is mounted on the board. The mold then is filled with sand, which is rammed well around the sides of the flask and tramped and rammed lightly over the remainder of the mold. The drag is struck off and sand sprinkled over the surface to give a firm setting for the bottom board, which is placed on the top, and the pattern, flask and bottom board clamped together. Then the mold is rolled over.

Make the Molds

After the clamps are loosened, the pattern and follow board are withdrawn from the mold. After shaking parting compound over the surface of the mold, and riddling sand over its face, the cope is placed on the drag. The cope contains wooden bars on 6-inch centers. Gate and riser sticks are placed in the proper positions and the mold is filled partly with sand. Gaggers then are aranged in their respective positions and the mold is filled and rammed. In this particular mold, 35 gaggers were used in the cope. After the cope is rammed properly, the gate and riser sticks are removed, the cope is lifted from the drag, and the drag finished. Runners are formed by sticks of the desired length embedded in the drag. Those are removed and the gates are cut from the runner to the desired location in the mold.

Fig. 5—Art Casting With Gates and Risers Attached

If that method is followed, an exact duplicate of the drag indentation formed previously by the pattern is obtained as a core extending from the cope. If the mold were poured in that condition, no casting would result because no allowance has been made for the thickness of metal. After the cope has been removed from the drag, a section of the part of the cope that extends from the surface is shaved away to provide the required metal thickness. The result is that the part of the mold that extends from the cope, although not an exact reproduction of the drag impression, closely follows its contours and gives a relatively even thickness of metal.

When the cope and drag are finished, they are sprayed with molasses water and a coat of graphite is shaken on the face. The graphite is smoothed around the gates by hand and over the remainder of the surface of the mold with a camels'-hair brush. The excess graphite is blown off with a bellows. Lycopodium then is shaken on the graphited surface, the excess blown off and the pattern is printed back in the mold to be sure that the casting will contain all the fine details shown in the pattern. Following that operation, the mold is closed to see that everything is in satisfactory condition to pour. The mold then is opened and allowed to stand.

Pours Metal Fast

As the time for pouring the mold approaches, the molder skin-dries the mold with a blow torch. The mold then is closed, to see that no weakening has taken place and opened again. If everything is in satisfactory condition, a mixture of flour and water is made which has the consistency of putty and is rolled into long, round, thin pieces which are placed around the drag section of the mold near the edge of the flask. That is used as a precaution against the metal running out of the flesk. The mold then is closed and the joint between the cope and drag sections is filled with the previously mentioned mixture but of thinner consistency. That is an additional precaution against a runout. Following those operations the mold is clamped and is ready to pour.

Molding a tubular casting, shown in Fig. 7, with its length, small cross

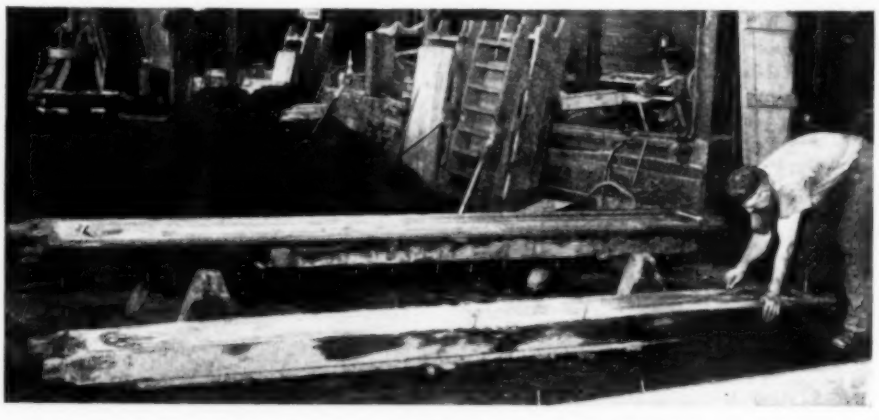


Fig. 6—Long Thin Castings Are Gated and Poured at Both Ends. As Soon As the Metal Is Solidified, the Gates Are Knocked off To Prevent Cracking

section and thin walls also is an interesting procedure. These castings are cast two in a mold and involve the use of a core ⅝-inch square and over 6 feet long. Molding operations for that type casting are practically the same as for the casting previously described. After the mold is complete the core is ready to be set. The core is made in two sections and is held in place in the mold by eight cast iron chaplets, four in the cope and four in the drag. Metal is introduced into the mold through two sprues located midway between the two casting cavities and at the ends. The sprues are connected with a central runner from which seven gates are cut to each mold.

The mold for another type casting ⅜ inch thick, approximately 4 inches wide and 9 feet long, shown in Fig. 6, is gated from the ends of the castings and the metal enters the mold through two passageways from each sprue.

The John Harsch Bronze & Foundry Co., of which John Harsch Sr., who this year is celebrating his fiftieth year in the foundry industry as apprentice, molder, foreman, superintendent and executive, is president, also cast the large eagle which is shown in Fig. 1. This was cast of aluminum in six sections and weighs 1161 pounds. The assembled figure is 10 feet high and 20 feet wide. The wings alone are 7 feet high and 4 feet wide. This casting will be located at the front of the building and a flag pole will be included as a part of the unit.

Tells Quad City Group of Plant Practice

One hundred foundrymen from the Quad-City area and distant points gathered at the Fort Armstrong hotel, Rock Island, Ill., Sept. 21, to hear M. J. Gregory, factory manager, foundry division, Caterpillar Tractor Co., Peoria, Ill., address the Quad-City Foundrymen's association on "General Foundry Practice" as carried out in his plant.

The speaker pointed out that the importance of ideal working conditions were considered when executives of the Caterpillar company originally planned the foundry. A modern foundry erected on made land

Fig. 7—This Hollow Tube Is Cast Two in a Mold. The Castings Are Gated from a Central Runner from 7 Places and Are Poured from Both Ends

permits production of castings with minimum discomforting labor through modern equipment for production as well as ventilation, heating and lighting.

The foundry proper is 500 x 375 x 40 feet. Equipment having full automatic, semiautomatic and manually controlled starting and stopping devices is used. Mr. Gregory started with the core sand mixing operation and described how one man mixed all core sand used in producing 140 tons of castings, many with complicated cores. Electrically controlled meters, dumping devices and mixers are employed in core sand mixing. An overhead crane delivers sand to the coremaker. The core ovens are gas fired, automatically controlled and of the continuous type. Some few cores require blackening and are dried in separate ovens.

Charging is done entirely by crane and an electric magnet. Four men are needed on the charging floor and outside to charge all the materials necessary to melt 140 tons of metal. Special buckets are employed and cast iron bricks are used at the charging door to protect the lining from falling pigs. Two blowers are controlled by the tap out man, who also tips the receiving ladles by the use of electrically operated mechanism. Slag is handled at the rear of the cupola and runs into a wire basket immersed in water, the action of the water breaking up the slag into small particles, facilitating its disposal. A monorail system is used in carrying iron to the various molding floors.

Approximately five thousand different snap flask jobs are in current use. Standardization was necessary to make it possible to handle this large variety on the conveying system. Approximately 5000 molds are made by 23 men on this unit. The molds are dumped automatically and shaken out at the same time.

The metallurgy of the new diesel engine cylinder liners was discussed at length and 3.25 per cent total carbon, 0.80 per cent combined carbon, 1.65 per cent silicon, 0.15 per cent phosphorus, 0.65 per cent chromium, 1.48 per cent nickel was given as the analysis of a typical charge which produced a strong iron having a brinnel of approximately 215 before heat treatment.

Hoffman Moves Plant To Syracuse

The directing personnel of the U. S. Hoffman Machinery Corp., New York, recently has been reorganized. The following men have been elected officers of the firm: A. C. Bruce, president; George Bowdoin, vice president and treasurer; and Charles Brewster, secretary. A. W. Bennett remains as manager of the Syracuse plant.

Other changes also have been made. W. J. Murphy has been appointed general superintendent to succeed Olin E. Piddeck, resigned and W. Perry has been appointed foundry foreman to succeed Joseph E. Miller, also resigned. The U. S. Hoffman company recently purchased the Vorclone Corp., Milwaukee, manufacturers of laundry and pressing equipment and has moved that plant from Milwaukee to Syracuse, N. Y.

Irving H. Jones, formerly associated with the Crucible Steel Co. of America, has become western district manager of the Molybdenum Corp. of America, with headquarters at 208 LaSalle street, Chicago.

Fig. 8—Two Types of Castings Which Will Be Used To Decorate the Interior of the New Pittsburgh Bank

Molding Sand Condition

Is Related to

Pin Holes and Low Ductility

By George Batty

WHAT has been described as the low ductility problem came into being as a result of the application of aluminum as a deoxidizer to metal used in the production of light steel castings from acid electric steel. The curing of pin holes by dosing the steel with aluminum does not cover the whole gamut of the causes which tend to reduce the ductility of cast steel. Pin-hole trouble and low ductility problem are identified particularly with green-sand practice.

Castings Are Unstressed

Green sand has the property of producing cast steel pieces relatively unstressed by mold resistance, but it has the tendency to inject gaseous mold products through the initially solidified envelop of metal into the castings. The amount of this injection is related to the composition and constitution of the molding sand and to the temperature of the metal.

Mold gases cannot come from silica grains which are the bulk and basis of molding sand but are derived from the binding media. The tendency of a green sand to blow and produce blows and pin holes is related to its moisture content; to its content of binder which produces gases when subject to heat attack; to the actual temperature of the metal; to the proportion of heat application, as relating to local ratio of metal to mold; and to the true permeability of the sand.

A survey of the fundamentals has led to a system of producing a synthetic molding material for use as green sand that is largely free from the disabilities and deficiencies that were inherent in the molding sands which promoted both the pin-hole trouble and the low ductility problem.

There can be no doubt as to the original seriousness of the pin-hole trouble as manifested in many castings produced by the green-sand process, and each manufacturer sought a solution of the problem. A ready remedy for the pin-hole condition was found by adding to the steel an amount of aluminum which varied, in different foundries, from 8 ounces to 2 pounds per ton of metal. In producing light steel castings, hand shanks or small bull ladles are used and the general procedure was to add aluminum to the hand shanks in an amount equivalent to the prearranged amount per ton of metal. Some founders regularly could eliminate the pin-hole trouble by a small addition of aluminum, whereas other founders had to use a much larger dose to obtain the elimination of the trouble.

Sand Is Cause

USE of a proper molding medium has eliminated sources of pin hole trouble by solving the problem of properly carrying off of gases from the mold. This article, abstracted from a paper presented at the recent Chicago convention of the American Foundrymen's association, explains the causes of aluminum embrittlement and gives a molding sand mixture used to eliminate pin hole troubles. It explains why the addition of aluminum to shank ladles results in the formation of alumina and discusses the various methods of addition. The author is director, Steel Castings Development bureau, Philadelphia.

Some time before the formation of the Steel Castings Development bureau, an investigation was started with a view to determining the causes of certain low ductilities noted as occcurring in the production of light steel castings, as evidenced by poor elongation and reduction of area in tensile test pieces. The late J. V. McCrae was engaged on this work under the research associate plan at the bureau of standards and when the author became associated with the Steel Castings Development bureau in 1928 some work had been done contributory to results given in *Proceedings* of the A.S.S.T.

About the middle of 1928 the investigation was being conducted along the lines of a study of the deoxidation of steel, and the author suggested that, while the accruing data were sure to be interesting and instructive in several respects, it hardly could be hoped that the solution of the low ductility problem lay entirely in the use of a deoxidizer other than aluminum. The author insisted, and still insists, that the low ductility problem arose primarily as a result of the type of cure adopted for the pin-hole trouble.

Reoxidation Is Cause

The author suggested that the problem could not be focused accurately by a consideration of the matter as relating primarily to the deoxidation of the steel then used in the foundries promoting the investigation, because it was demonstrable that such steel would produce sound castings, free from pin-hole penetration, in dry-sand molds, core molds or skin-dried molds. It was insisted that the pin-hole trouble had not arisen as a result of failing to deliver satisfactorily deoxidized steel to the molds, but was caused by the reoxidation of the metal by certain types of molds.

The author's insistence upon mold variations as the primary source of pin-hole trouble was based upon a type of test mold he had adopted to serve as an indication of the suitability of sand in use as a molding medium. The test mold was devised to record the effect of both green mold and dry mold on a sample of steel. A section through this test mold is shown in the accompanying illustration. One shoulder of the test block is produced by a core, the remainder of the mold being green sand. The quick method of checking on these test blocks was to chip along the radius below the head of the test block. Where any pin-hole penetration was found, it was invariably at the green-sand shoulder which conforms with the typical internal angles of steel castings that were found to be most subject to the tendency of pinhole trouble.

The formation of pin holes inevitably represents some reoxidation of the metal and the problem becomes one of preventing the reoxidation of the metal within the mold rather than one of pouring metal which contains a powerful deoxidizer in addition to the normal safe amounts of deoxidizer that have been used to make the metal normally sound.

That the problem is one of preventing the reoxidation of the metal, is known because the use of a powerful deoxidizer, such as aluminum, results in the formation of deoxidation products which promote embrittlement. Further, the liability to embrittlement is related to the amount of inclusions formed by the combination of the deoxidizer with an immigrant mold gas. If a large amount of gas is injected from the mold, a larger proportion of alumina will be formed than if only a small amount of gas is injected.

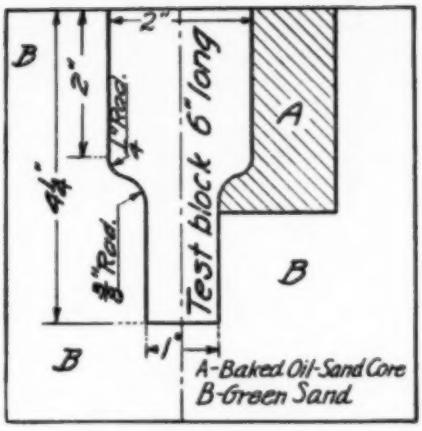
Hydrogen May Be Absorbed

Moisture of green-sand molds provides the majority of the immigrant gases, and if it is conceded that the dissociation products of water are injected into steel in a mold, the hydrogen may be absorbed largely by the metal and the oxygen combined with the aluminum or other powerful deoxidizer used. If it is conceded that immigrant mold gases and not gases coming out of solution from the steel are the cause of pin holes, the trouble definitely must be identified with the mold and not with the metal.

It must be understood that the author believes blows and pin holes to be due entirely to a constitution of mold incompetent to evacuate in the proper direction all the additional volume of gas generated by the heat attack of the metal upon mold constituents.

Castings that have appeared sound before annealing and pin holed after the removal of the annealing scale is indicative of an *early* blow from the mold. An examination of such castings frequently will reveal cavities within the metal near an internal angle of the mold that have no connection with the interior surface of the casting but are isolated totally. The most general pin-hole condition that had to be cured was caused by a *later* blow from the mold which produced pin holes of such form that they could be seen at the internal angles of the castings after the sand-blasting operation.

It is believed that most blows and pin holes in green-sand castings were caused by the moisture content of the sand, because it is quite easy to establish the fact that skin drying will permit the production of perfectly sound castings from molds which would have produced hopelessly pin-holed castings if used in the green state. Skin drying does not result entirely in the evolution of the moisture at the surface of the mold. Some of the moisture is driven back from the face of the mold into the interior as water vapor and is condensed by the cooler sand with which it contacts. In a properly skin-dried mold this condensate film is so remote from the mold-metal interface that the solidified envelop of metal is so thick when the gas pressure becomes acute that it can resists penetration. By preventing the injection of mold gases, it should be possible to prevent the formation of pin holes and thereby should be absolved of the necessity of using a suplementary powerful deoxidizer as a late addition to the pouring ladles.



Section of Test Block Mold. Section A Represents Baked Oil-sand Core and B Green Sand

Alumina in the Furnace Metal Has a Chance to Levitate

It has not been possible to produce a green sand which will not inject some gas into the castings, but the procedure of producing green sand has been modified so that the injection of mold gases almost is insignificant. As a result, the amount of proportion of alumina embrittlement has been reduced so that the low ductility problem substantially has been solved.

However, investigations are proceding with a view to finding a method of applying a deoxidizer that will not have the same effect as aluminum in promoting decreased ductility.

When aluminum is used as the supplementary deoxidizer, the product of the reaction with an immigrant gas is alumina. We have no evidence that 0.05 per cent aluminum in steel exercises any serious embrittling effect, but we have some considerable evidence that a small amount of alumina promotes a noticeable degree of embrittlement. If the injection of mold gases is limited, the formation of alumina will be limited and the resultant product proportionately influenced in respect of ductility as compared with an identical steel cast without aluminum addition.

Alumina Causes Embrittlement

Comstock has suggested that "in the aluminum treated steel . . . the sulphides are practically always extremely fine and arranged more or less distinctly in streaks forming a sort of fragmentary network. Steels cast without aluminum normally have their sulphide inclusions coarser, globular and more scattered, like the silicate globules. In the tensile test the streaks of fine sulphides have a tendency to cause cracks to open up in the specimen after the yield point is passed, and these cracks grow under the increasing load so that the specimen breaks with less elongation and reduction of area than if the cracks had not opened. . . . We have found that low ductility could be correlated with the streaky sulphide arrangement more closely than merely with the presence of segregated alumina inclusions, although, as stated, both these characteristis often occurred together."

In relation to the foregoing quotations of Comstock, it is interesting to note that the alumina embrittlement of basic electric steels of low sulphur content is less marked than is the case with the acid electric steels of higher sulphur content. It does not seem to be known generally that some aluminum is added to a charge when the ordinary commercial brand of ferrosilicon is used as a deoxidizer. Undoubtedly the aluminum so added contained in the ferroalloy, has considerable opportunity for levitation, as alumina, both in the furnace and in the ladle. Hence, we are

not likely to find any aluminum present in a sample of steel taken from the ladle as it is delivered to the pouring floor.

The remedy for the pin-hole trouble lies in producing a suitable molding medium for green-sand practice, and some considerable investigation as to the best molding media has been made by the foundries who are members of the Steel Castings Development bureau. It is found that, by using a pneumatic exhausting system in combination with vibratory screens, sand may be reclaimed and put into excellent condition for reuse.

The bonding media employed are bentonite and a cereal binder. Regularity of grain size is an essential, and a supply of sand is used as the basic material which is regularly subangular or rounded in grain shape. Sand control of the reclaimed material is directed to maintain a proportion of not less than 4 per cent and not more than 7 per cent of fines. As the reclaiming system embodies a pneumatic extractor, there is a fair assurance that finely divided ferrous oxide is withdrawn almost completely from the sand and, there is no accumulation of this dangerous component in the reclaimed sand through its many cycles of use.

New sand is introduced almost entirely as oil-sand cores which, after exercising their primary function, become the new material to repair the wastage resultant upon sand adhering to castings and such part of the sand as is fragmented so finely in service as to be eliminated by the screen or the air exhaust. The majority of the grains of reclaimed sand are coated finely with strongly adherent unperished bond, and only a small amount of new bonding material is added to the reclaimed sand to produce the regular molding sand.

Recommends Pouring Test

Suitability of the green sand for molding readily is assessed by pouring test blocks into molds of the type illustrated in the accompanying illustration. Use of such an actual service test is strongly commended as an amplification of the more regular sand-control methods practiced in the routine determination of permeability, moisture content and strength.

Chipping or grinding the two internal angles produced beneath the head of the test block serves as a reliable indication of the suitability of the molding sand. At the same time, the test block will identify any heat of metal that is improperly made, in respect of adequate deoxidation. Pin holes from the green-sand shoulder of the mold definitely indicate a dangerous molding medium, while subcutaneous blow holes at both shoulders of the mold indicate an unsound, wild, or blowy metal.

In an earlier part of this article, it was suggested that mold gases injected into aluminum-treated steels created almost the whole of the low ductility problem. Causes other than injected mold gases may produce the embrittled condition in steel for castings, and brief mention of two of these causes may be made here as separate from the interrelationship of the pin-hole trouble and the low ductility problem. Alumina undoubtedly promotes an embrittled condition in steel for castings, but such alumina may be produced as a result of careless practice in the foundry.

George Batty

The actual method of adding aluminum to a hand shank or small pouring ladle inevitably involves some small production of alumina and consequently some proportionate effect upon the ductility of the metal. It is considered safe practice to insure the presence of a small amount of aluminum in steel for green-sand castings so that there may be present a safeguard against pin-hole unsoundness in the case of a small but not serious injection of gases from the mold. This inevitably involves some slight recession from the higher standard of ductility obtainable from steel of identical composition other than the aluminnm addition.

With proper control of sand composition and mold constitution, the degree of depreciation of ductility is reduced so as to make possible the meeting of the standard specifications with a fairly generous margin in respect of both ductility and strength.

Sand is the chief problem, and it is appalling to contemplate any negation of the care exercised in sand preparation as a result of careless practice in adding aluminum to the pouring ladles that are to produce the small castings. In the course of the author's experience a number of defects have been noted and almost entirely eliminated in practice.

A hand shank returning to the large ladle for a further supply of metal often contains a small amount of steel which is still liquid, and if aluminum is added to this small amount of steel in the hand shank and then an interval of even a few seconds supervenes before the hand shank receives the further supply of metal from the large ladle, almost the whole of the added aluminum will be oxidized and will contaminate the shank load of steel with alumina. Aluminum should be added to hand shanks as the metal is flowing from the large ladle into the shank, and care should be taken to throw the aluminum into the stream of metal so that it may be carried down as far as possible below the surface.

Keep Ladles Clean

Shanks or pouring ladles with dirty lips promote the formation of alumina in the metal either before or as it enters the mold. A shank or pouring ladle is considered dirty when it has a film of solidified metal upon any part of its interior surface. Solidified metal oxidizes readily and, when the shank receives another load of metal and its usual amount of aluminum, the oxide of iron on the solidified film inevitably is reduced by the aluminum with the formation of alumina. Alumina, no matter how produced, involves or promotes some embrittlement of the steel.

The addition of small pieces of aluminum to the stream of metal as it enters the mold is deprecated as being likely to produce uneven aluminum distribution through the casting. If pellets or small pieces of aluminum are thrown into the stream of metal as it enters the mold, hard spots may be produced in the casting as a consequence.

Silica or silicate inclusions may be the result of inferior melting practice or may be the result of either inferior mold materials or inadequate molding method. So far as silica or silicate inclusions in the metal are concerned, it is well to remember that aluminum appears to have the ability rapidly to break up such compounds with the resultant formation of alumina. A dirty steel, that is, a steel appreciably contaminated with finely divided silica or silicates, will become contaminated with alumina by the simple addition of aluminum to the hand shanks or pouring ladles.

The production of clean steel is a matter that impinges directly upon the low ductility problem; but, notwithstanding the foregoing potential causes of embrittlement, it is asserted that the real low ductility problem was primarily the result of overcom-

ing the pin-hole trouble by making aluminum additions to the steel in the poring ladles. Having established as a fact an ability to overcome to a large extent the tendency of green-sand molds to inject oxidizing gases into the casting, it is believed that the major cause of decreased ductility is overcome.

Adds Lights for Greater Safety

ADEQUATE plant lighting is of material advantage to any industry for it increases both efficiency and safety. Proof of the increase in safety lies in the fact that more industrial accidents occur in winter when there is a deficiency of light than in summer when there is an abundance. Increases of as high as 68 per cent in efficiency have been noted in plants which have increased the amount of light available by 35 per cent.

With this in mind it is easy to see that proper lighting is of importance of the foundry. That industry finds the problem of providing sufficient light difficult due to the certain amount of dust in the air, which has a tendency to decrease the efficiency of the installation. To overcome that difficulty, bulbs and reflectors must be kept clean.

New System Installed

Looking foreward to the approaching winter when sunlight is limited and foreseeing the future when increased demand on its capacity will require a night force, the Ohio Foundry Co., Cleveland, which operates two plants, has installed a new lighting system in the plant located at 9610 Quincy street. The company manufactures castings for stoves, heaters, electric motors, etc. The foundry is housed in a rectagonal building consisting of two parallel bays extending lengthwise of the building, with a small bay and the core room located at the end.

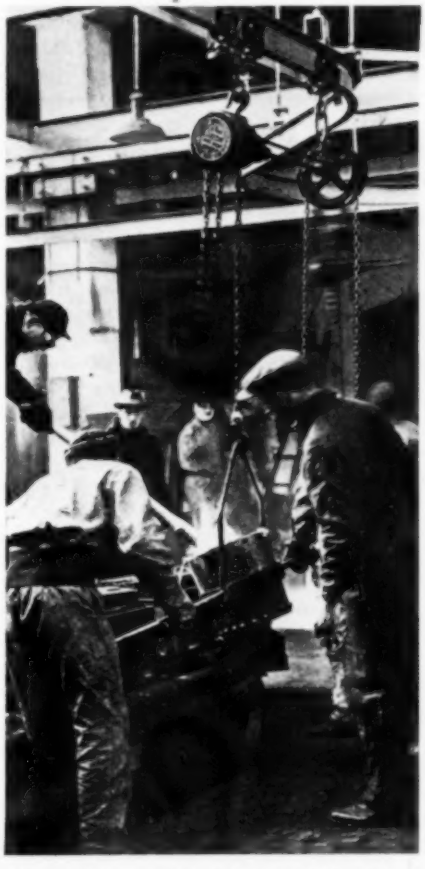
In providing artificial light it would be possible to illuminate each molding machine individually and thus secure sufficient lighting for operation. However, such a system, if not installed carefully permits the light to glare in the men's eyes, a condition which is not conductive to good work. Instead a system of direct lighting utilizing reflectors usually is installed where large areas are to be illuminated. That system has been employed by the Ohio Foundry Co.

The installation consists of 56 outlets or points of illumination located 25 feet apart and 12 feet from the ground. Light is supplied at 110 volts, direct current, through 300 watt bulbs. Dome type reflectors diffuse and intensify the light. Shadows and glare are two deficiencies often present in lighting installations. Shadows often make it difficult for workmen to see the work properly and glare produces the same effect by contracting the pupil of the eye. In a recent test, it was found that the system installed by the Ohio company allows no shadows and glare has been reduced to a minimum.

Conditions Vary Requirements

According to an article by A. Paulus in the Oct. 1, 1930 issue of THE FOUNDRY, each section of a foundry demands different treatment of the artificial lighting problem. That author gives the following intensities as those required for foundry operations: Charging floor, tumbling, cleaning, shakeout and pouring, 5 to 8 foot-candles; rough molding and coremaking, 6 to 10 foot-candles; and fine molding and coremaking, 10 to 15 foot-candles According to the *Mechanical Engineers' Handbook*, the desirable mounting height in industrial interiors for direct lighting units is 12 feet.

The installation conforms to the recommendation as to the height of units but falls slightly below the minimum foot-candles recommended for rough molding. The condition is due to difficulties of installation. Probably the best location for the outlets was along the trusses that support the roof of the foundry building for those locations allow maximum durability and strength in the system and reduce the cost. Since the trusses are 25 feet apart, it was decided to place the outlets on 25-foot centers to give evenly distributed illumination. Cost was reduced by eliminating the supports which would be necessary for the conduit if the outlets had been spaced sufficiently far apart to give maximum illumination.



Good Lighting Is Essential for Good Workmanship

Natural Light Available

Another consideration also entered the installation of the system, The foundry department is housed in a building where light is available through windows on all sides and extending from approximately 5 feet from the floor to the roof. Light also is available through openings in the roof. Since a large amount of natural light reaches the molding floor, even during the winter, it seldom is necessary to use the artificial variety. If a night force is working, only artificial illumination is available and according to a recent test, the new system gives much more light than the one formerly used.

As has been previously stated, a certain amount of dust always exists in the foundry. When dust accumu- through windows on all sides and exficiency often is reduced as low as 50 per cent. As a result of the dust conditions, bulbs and reflectors must be cleaned often. To overcome the collection of dust on the bulbs and reflectors and to facilitate cleaning, the Ohio Foundry company is contemplating the installation of globes under the bulbs and attached to the reflectors.

Production of steel castings in August totaled 30,920 tons composed of 8657 tons of railway specialties and 22,263 tons of miscellaneous castings. New orders for the month totaled 28,016 tons compared with 32, 869 tons in July and 50,370 tons in August, 1930. The report of the department of commerce, bureau of the census also shows that bookings for the first eight months of 1931 were 307,426 tons against 691,829 tons in the similar period of 1930.

Prevent Losses With Proper Gates and Risers

By Pat Dwyer

TWO principal methods are employed in the production of piston rings. In one the ring is cast as a cylinder or a section of pipe. After this casting has been cleaned it is placed in a machine, finished inside and outside and then divided into a number of individual rings. In the second method the individual rings are cast approximately to the correct size and then are machined and finished as individual rings. Each method presents advantages and disadvantages, but a discussion of these features lies outside the scope of the present series of articles devoted to a consideration of gates and risers.

Dirt Carried Past Gate

Method of gating these piston ring pots in a prominent British foundry is shown in Fig. 100, a view looking directly down on the drag. Metal is poured into an upright sprue at *A* and runs along the horizontal channel until it comes to *B* at the opposite end. Here the runner is enlarged to correspond with a riser opening through the cope. The theory, borne out by practice, is that the metal carrying any foreign inclusions, will carry these inclusions to the end of the runner. With the runner and riser full, the clean metal underneath will flow back through the tangential gates into the upper ends of the castings. As an added precaution, an iron plug is held in the top of the sprue opening until the pouring basin is filled with molten metal.

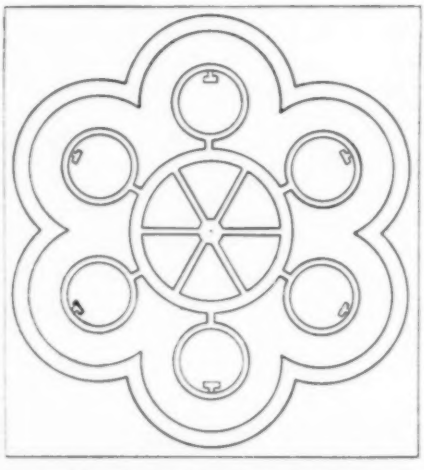


Fig. 99—Typical Layout for Gates, Runner and Small Piston Rings

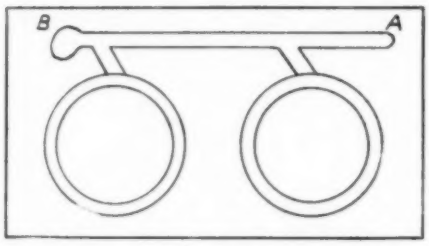


Fig. 100—Metal Enters the Runner at A and Flows To B Before Entering the Molds

Metal patterns leave their own cores in these molds made on a hand ram, roll over, pattern draw machine. The flat copes are rammed on a second machine. One molder puts up 90 molds and pours his own iron. Usually 16 rings are cut from each pot, a total of 2880 rings per molder per day.

Individual or single piston rings generally are made from patterns mounted on plates. Squeezer type molding machines are employed to form the molds. The pattern plates and the flasks may be circular or square, or variations of these shapes. The number of patterns on a plate depends on the size of the rings. On the smaller sizes the number ranges from 5 to 12. The patterns are arranged radially from a central sprue. Each ring pattern is slightly oblong instead of a true circle. This out of round shape is intentional, to compensate for the removal of a small portion of metal later when the gap is cut in the ring.

Button Prevents Chill

The length of the extra piece of metal in the ring varies and depends upon the degree of tension or spring desired in the finished ring. This insert or gap section is placed at the point where the branch gate enters the ring cavity. Provision is made for a comparatively heavy piece of metal either on the outside or the inside and at the opposite side of the ring. This is called a button or pollywog and its purpose is to serve as a small heating element to prevent the metal from chilling on the side of the ring farthest removed from the gate. The button varies in size. On the average size auto-

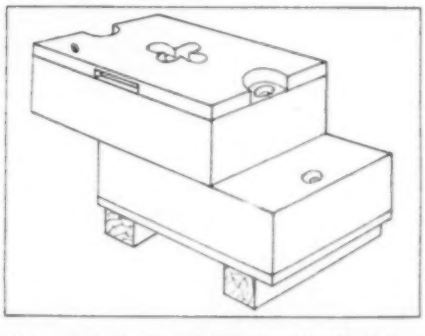


Fig. 101—One Method of Stacking Small Molds. The Lower Mold Is Poured First

Molds Are Stacked

ALTHOUGH the practice of stacking molds is not new, and although some of the early experiments did not come up to expectations, the practice now obtains quite extensively, particularly in the production of piston ring castings from individual patterns. Where formerly a stack of molds three or four high was considered the limit, stacks now are built up to a height of 18 *sections. However, all types of molds are not adapted to the stacking process. Individual cases can be decided only by experience and experiment. The method presents interesting possibilities. Meritorious features of small gates and high heads figure in the abstract of a paper presented several years ago before a convention of the American Foundrymen's association. The paper applies particularly to cases where large numbers of small pressure resisting castings are molded and poured in small flasks.*

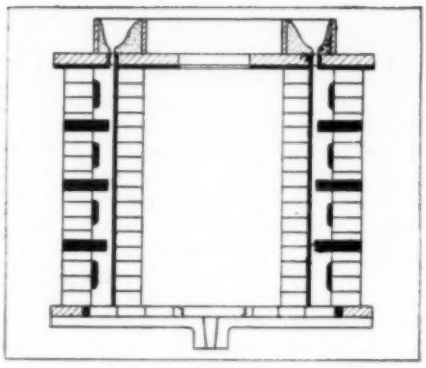


Fig. 102—Certain Types of Castings Lend Themselves To Multiple Molding in Loam

mobile engine piston ring it is 1-inch in length, ¼-inch wide and ½-inch thick.

In some of the early experimental work, some foundrymen had little success with stacked molds and abandoned the idea of pouring piston rings in this manner. Later work by others demonstrated that the method is quite feasible. At present all the large makers of individual piston ring castings, pour the iron into stacked molds. A little practice is required to develop a technique that will not strain the molds in the bottom strata before the molds in the upper strata are filled.

Stack the Molds

The molds are stacked from 12 to 18 high and are poured through a central sprue connected at each mold joint with gates leading to the ring cavities. Closely controlled cupola practice and exceedingly hot iron are essential to the success of this method.

A typical layout of patterns and gates for one of these molds in a prominent midwest foundry is shown in Fig. 99. The central sprue distributes the metal through the radial branches to a ring gate a short distance inside the various mold cavities. The radial branches are staggered, that is to say they are disposed in a manner that will not bring them in line with the individual gates entering each mold.

Since the practice of stacking molds is not observed universally, a brief general reference to the subject appropriately may be introduced at this point for the benefit of those who have not seen, heard or read of molds made and poured in stacked formation. The method may be divided into two general classes. The first is confined to snap flasks in which part of the pattern is molded in the cope, or where there is an irregular parting, also where the sprue may be placed close to one end or one side of the mold, instead of in the center.

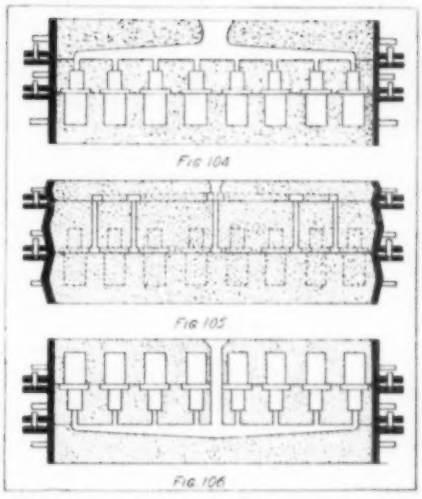
After the first row of molds has been laid down on the floor, the second row is placed on top in such a manner that the sprue opening in each of the first row is exposed. This feature is shown in Fig. 101. All the molds in the bottom row are poured before any metal is poured into the molds in the upper row. This precaution is observed, to prevent either splashes of metal, or other material from falling into the sprues in the lower row, practically a certainty if the upper molds were poured first.

The second method is confined to molds either with flat partings, or, to molds made in such a manner that each section contains a cope and drag impression of the pattern and usually, with the sprue in the center of the flask. However, this last feature is not universal. In some instances the second method is employed where the sprue may be close to the edge of the flask, either at the end, the side, or in a corner.

Three typical stacks of molds made according to the second method are shown in Fig. 103. These stacks range from 3 to 18 sections in height, depending on the thickness and weight of the castings. In *A* the mold sections are made in iron or steel flasks with the entire mold cavity below the parting line. The bottom face of each drag serves as a cope face for the mold cavity immediately below. In *B* each mold section also made in a metal flask, contains cavities in both faces which coincide when the sections are assembled. This arrangement is for patterns in which the shape necessitates molding part in the drag and part in the cope.

Where the molds are made in a snap flask, as shown at *C*, flat steel bands which fit snugly inside the snap flask are rammed up with the mold and prevent it, particularly the lower sections, from bursting when filled with liquid metal under a high head. Metal slip jackets, in some instances are employed for the same purpose.

The first drag with the steel band around the perimiter is rammed in



Figs. 104, 105 and 106—Alternative Methods of Arranging Gates and Runners in a Three Instead of the Usual Two-Part Flask

the usual manner on the bench or on a machine. It is turned over and placed on the floor or on a suitable bottom plate or board. A plate is preferable. It will not yield under pressure and it will last for an indefinitely long period. Bottom boards are a constant source of trouble and expense, especially if the castings extend deeply into the drag. Boards warp and twist and invariably burn out in a short time. Metal seeps through the crack in the center.

Splash Over the Edge

If metal does not go through, the vent soon burns the board until it is unfit for use. Usually the molder working at high speed on a piece rate basis, will take a chance on a doubtful board. Only after it has given way and spoiled a casting, is it discarded finally. Light, strong steel bottom plates now are available everywhere.

A gate pin is placed at a convenient point in the second and succeeding flasks to form a continuous opening from the top of the stack to the

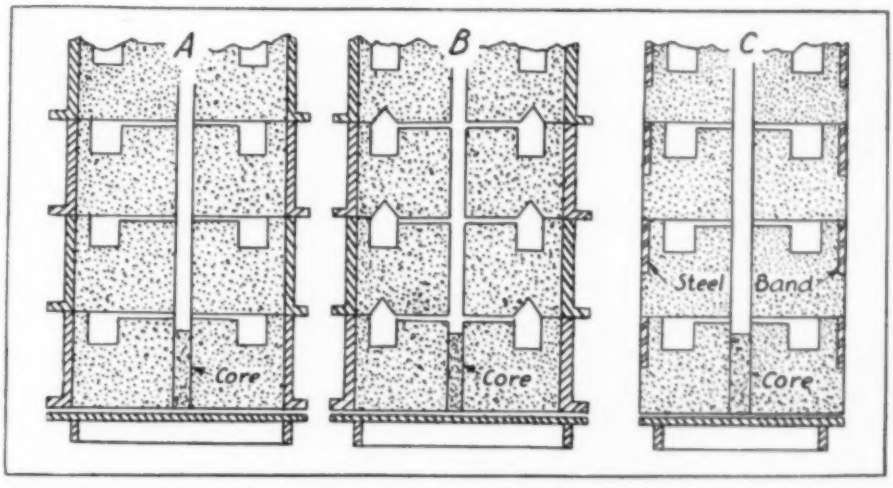


Fig. 103—In A the Entire Mold Cavity Is in the Drag, in B the Cavity Is Formed Partly in the Drag and Partly in the Cope. The Use of Steel Bands in Snap Flask Molds Is Shown in C

lowest joint. In some instances, as shown in Fig. 103 the opening extends through the bottom section. In instances of that kind, a short piece of stock core is dropped into the opening in the bottom drag, or a handful of green sand is packed into it, before the second mold section is placed.

The last or top section is rammed as a plain cope or it may be rammed the same as the others with the upper end of the sprue reamed out in the usual manner to form a funnel or pouring basin. Where the stack is to be poured with a small hand ladle, this reaming is not necessary, but where a bull ladle is employed, with a correspondingly larger stream from the lip, it is necessary to provide a suitable opening to prevent the metal from splashing over the edge of the mold and onto the operator's feet.

Presents Many Advantages

Neatness in pouring metal not only is advisable from a safety standpoint, but also is an economical measure since it prevents waste of metal, besides the extra labor involved in collecting the scrap. Incidentally it helps to maintain a clean sand heap. Where a sand cutting machine is employed, scrap and shot iron delay operation, may cause accidents and impose severe wear on the blades of the mixer. Any considerable amount of spilled metal represents sloppy practice and will not be tolerated by a foreman who takes a proper pride in his work and the appearance of his shop floor.

The principal advantages of the stacked mold process are that it increases the capacity of the floor space from 100 to 1800 per cent. It reduces the amount of sand required for a given tonnage of castings by eliminating from 1 to 17 copes. It increases production to a corresponding extent and relieves the molder of a great deal of heavy labor incident to handling a large volume of molten iron in a hand ladle. Where a monorail or small crane is available, the stacked molds may be poured from a bull ladle.

Discretion must be observed in the style of molds suitable for stacking and that is something which only can be acquired through experience and experiment. A great many molds made and poured singly, might just as easily be poured in stack formation.

Used on Large Molds

Stacked molds, or multiple molds, in many ways the terms are synonymous, represent fairly common practice in shops devoted to the production of light castings, but the practice has not been adopted to any great extent in foundries where the castings are large and heavy. Isolated instances are noted occasionally, but not by any means as frequently as the many economical features, saving in floor space, time, labor and material, would seem to justify.

A typical example of the method applied to the molding of four tire castings in a multiple mold is shown in Fig. 102. The mold was built up in bricks and loam and the different sections were separated by dry sand cores made in sections and built into place in the outer wall of the mold.

The crown or cover plate was provided with several generous size openings for gates and risers and in that manner was available for other molds. Gates were filed on the inner edge at the joints of the dividing cores and directly in line under corresponding pop gates somewhat smaller in area in the cover plate. As a possible feature of interest, the mold shown in the illustration was made in 16 hours by a molder and helper and produced a little over 3 tons of good castings.

Before leaving the subject of stacked and multiple molds it is pertinent to introduce reference to a method in which three part flasks are employed to make castings usually made in two part flasks. The following abstract is taken from an unusually informative paper on the subject presented by William H. Parry before a convention of the American Foundrymen's association in Rochester, N. Y., June 5-9, 1922 and which later was published in the Oct. 1, 1922 issue of THE FOUNDRY.

"****** Conditions incidental to the rapid production of sound castings, for example, castings to withstand severe pressure, tax the ingenuity of the most expert foundrymen. Many of these difficulties may be overcome by employing a three-part instead of a two-part mold.

Gate Is Important Feature

"With the almost universal use of production pattern plates, it is not unusual to find that such plates do not always produce as many good castings as the number of patterns would seem to promise. In fact instances are not unknown where not a single good casting has been found when the mold was shaken out. The claim is not made that improper gating is the cause of all these failures, but undoubtedly it is an important contributory factor. It is not always good policy in designing production pattern plates to crowd as many patterns as possible into the flask space with the idea of increasing production thereby. Frequently under such conditions, the result is exactly the reverse of what is expected.

"A staggered section of a three-part mold assembled, showing the sprue and runner in the cope, the pop gates and the upper part of the castings in the cheek and the lower part of the castings in the drag, is shown in Fig. 104. **** Apparently this is a simple two-part job. At first the work was planned for a two-part mold with gates entering the flanges from two longitudinal runners. The castings were to withstand hydrostatic pressure of 1000 pounds per square inch, were to be finished all over and hundreds of thousands were needed. Every casting made in the two-part mold was porous. Evidently some other method of gating must be tried.

"Various forms of pattern construction and various methods of molding were tried, but none was successful. Finally the long shot, the apparently nonsensical idea of making the castings in three-part flasks, was tried out with the most gratifying satisfaction.

Increase Number of Patterns

"Three pattern plates were made. The runners and about one-half the sprue were attached to the cope plate as shown in Fig. 104. The cheek plate carried the patterns for the upper part of the castings and the drag plate carried the remaining sections of the patterns. A pop gate was attached to each of the 40 patterns, projecting high enough to come flush or a trifle under the upper surface of the cheek and engaging with the runners specially arranged for the purpose. The sprue was so placed that the inrushing metal did not pour directly into any mold cavity. The runners were designed to give the most direct passage to the metal.

"With tight flasks it was found possible to pour 40 sound castings in each mold. This was 17 in excess of the number of patterns spaced on the two-part flask plates as designed originally and from which not a single satisfactory casting was obtained.

"One decided advantage in using the elevated method is that no attention need be paid to the runner or gate positions in placing or spacing the patterns, other than to keep in mind that they must not be staggered so that the runners have to depart from easy flowing lines. This method lends itself to direct pouring into the mold cavities and provides feeders to counteract the gravity shrinkage in castings with heavy and deep sections on each side of a light flange.

Risers Are Optional

"On the original two-part flask plates the gates engaged the flange so that the metal first flowed down into the drag, then up into the cope. In some instances the upper hubs were not filled and even when they were filled, a spongy area developed at the junction of hub and flange.***** In openly advocating a scheme that involves ramming an extra flask part for each mold, be it ever so shallow,

(*Concluded on Page* 38)

Scientific Rate Setting Predetermines Costs

By T. M. Harrison

TWO distinct kinds of time studies may be used by foundries in establishing rates. One is made with reference to the pattern or core box and the other to individual *elements* of the work. In all jobbing foundries and in many foundries making a standard line of product, time studying by individual patterns would be a tremendous and more or less continuous task. Consequently, the second method which deals with time-studies to cover elementary operations rather than specific patterns will be studied.

From the standpoint of that type of time study, molding and core making are not merely operations. Each represents a combination of a large number of elementary operations. In the case of each of these elementary operations, there is a unit that will measure the distinction in labor difficulty between one pattern or core box and another in molding, for instance, there are flask-handling, sand-handling, core and supply handling, finishing and other elements. Thus, it is only necessary to establish basic rates, expressed in the proper units of measure, to build up synthetically an over-all time allowance to cover the making of a mold from any pattern in any flask.

Make Charts and Tables

Under the system shown in the accompanying table, there are two distinct steps. The first is to make time-studies and build charts or tables covering all elementary time allowances. This is a task that is completed rapidly once and for all. The second step establishes time allowances for individual patterns and core boxes from the basic data.

In some cases these elements or groups of elements are measured by a single unit of time which is multiplied by the factor representing size, volume, or pieces. In other cases the unit changes with the size, volume or pieces and the basic data may best be presented in the form of charts or tables. As an instance, take the first group, which we will call flask handling elements. In that case the allowance per hundred square inches of flask area varies with the size of the flask and therefore may best be presented in chart form.

While there is some similarity between the time allowances as established in different foundries of the same type, it is necessary to make time studies locally to be sure that the standard times reflect the local conditions, equipment and methods. The time required to make such studies varies with the range of the work.

Subdivides Operations

IMPORTANCE of scientific rate setting to cover molding and coremaking costs is emphasized in this article, which is abstracted from a paper presented at the Chicago convention of the American Foundrymen's association. The author, who is a partner in the firm Stevenson, Jordan & Harrison, Cleveland, advocates a method which calls for the establishment of the time of various fundamental operations and then the determination of those which go to make up the elements of any particular job.

Assume that basic time allowances have been established covering all elements and that charts and tables have been provided to make the data readily available to the rate setter and it will be shown how the information is used. The first step in ascertaining a job rate is to determine the square inches of area in the top of the flask and the approximate square inches and cubic inches in the pattern, from which may be determined the cubic inches of sand. Whether the wage incentive system used is piecework or bonus, the original computation must be made in hours.

In jobbing foundries rate setting is a continuous task, and in any foundry it is a task that must be done every time a pattern goes into the sand for the first time. To calculate the time allowances on specific patterns requires that the patterns must be measured and certain computations made. This takes a varying amount of effort according to the type of work. The compilation for a molding machine pattern may be made in three or four minutes. On the ordinary run of side floor jobs the time per pattern may be six or eight minutes, and on center floors jobs, a longer time is required if the pattern is large and intricate. On miscellaneous work a rate setter may readily cover 60 or 70 patterns a day, and since the time allowances on these patterns need be computed only once, it will be seen that rate setting in a foundry of average size is likely to be a part-time job.

Work Pace Increases

Wage incentives are effective especially on such largely manual operations as molding and core making. The pace of day workers in these operations ordinarily is slow as compared with the pace that may be obtained under any effective wage incentive plan. Piecework or bonus frequently will double the output per man hour with a large percentage reduction in direct labor costs.

Jobbing foundrymen especially will assume that a system of this nature does not apply to the short runs inherent in jobbing work. This is a mistake. Once the elementary times have beeen established, the rate-setting problem becomes so easy that jobbing foundries have no longer any excuse for operating on a day-work basis.

The difference between piecework and bonus is not understood or appreciated by the average foundry executive. If the foundryman cannot picture piecework in his plant, he is likely to arrive at the erroneous conclusion that no wage incentive system is possible. The bonus system is so much more elastic than piecework that it may be made to work effectively under almost any condition. The short runs and other difficulties encountered in jobbing foundries may be covered effectively by a properly designed bonus system even where piecework might not be applicable so readily.

Where judgment is exercised in setting piecework rates the benefit of the doubt ordinarily is reflected in the piece rate. Minimized rates only can be arrived at where all elements are measured properly. In rate setting by judgment, there is no assurance that two rate setters will get the same results, or even that a given rate setter will get the same result at different times. Scientific basic data, on the contrary, leads to rates

that are not only uniformly equitable but ordinarily are lower, on the average, than can be hoped for under rule-of-thumb methods. Day work is a luxury few can afford. A good wage incentive system should reduce the labor cost in the average day-work foundry by about 25 per cent.

System Saves Money

It is difficult to generalize as to the value of scientific rate setting over rate setting by judgment in foundries now on piecework, because the saving will vary in accordance with the accuracy of the estimated rates. Scientific rate setting will save money, to say nothing of the value of relying for labor control on fixed fundamental data rather than wholly on the judgment of individuals, however well qualified they may be.

There is a woeful lack of cost knowledge in the foundry industry, and its outstanding troubles may be traced to that fact. What foundrymen have to fear is not competition so much as it is the unintelligent competition of the member who does not know his costs. Any system that aids in the determination of costs, therefore, must be regarded as important.

The chief difficulty in cost finding certainly is not in establishing the cost of the metal, for most foundrymen know the cost of metal at the spout. A large proportion of foundrymen, too, have an analysis of overhead detailed enough to enable them to apply that element of cost with reasonable accuracy. The greatest difficulty arises in the determination of the direct labor cost of each casting. In many foundries detailed time records are made by floating timekeepers, but even in such cases the allocation of time, especially on small work ,is more or less arbitrary.

Elementary time allowances provide a method of *predetermining* direct labor costs and, therefore, total costs by individual castings. They make possible a standard cost system. Foundry accountants who are familiar with recent developments will know that under this system all individual castings costs are predetermined, and variations from standard are drawn off in weekly and monthly periods merely by classes of expenditure.

Under standard costs, the actual cost of operating for the month is accounted for under two heads: First, the standard value of the product, and second, the variations from standard. The variations from standard are handled as follow: (1) Metal at the spout, variations from standard price per hundred, drawn off once a month; (2) direct labor, variations from standard time allowances drawn off by pay periods, by departments; (3) overhead expenses, variations from standard percentages and tonnage units, drawn off each month. The variations are treated not as charges to individual castings but rather as items of operating profit or loss. Standard costs have certain definite advantages in a foundry. They are more accurate than figures built up through day-to-day time keeping; the clerical labor involved in maintaining the system is much lower than it is under order costs; and the costs are known before the castings are produced.

In jobbing foundries, estimating is an outstanding problem. It has all the difficulties of the cost finding problem, with the added difficulty that the estimate must be made before the goods are produced. As in the case of the cost finding problem, the greatest difficulty presented is in determining the time required to perform the direct labor operations. However, if the estimator is working from exactly the same basic data as the rate setter, it is a foregone conclusion that the estimated labor costs will agree with the rates established in the plant . Again, if the estimator is using the same cost per pound for metal, and percentages and tonnage rates for overhead, it is apparent that the other elements in the computation will conform with those compiled by the cost department, provided the cost department uses standardized rates. Briefly, the estimate should agree with the actual cost if order costs are used. If standard costs are used, the estimate becomes the standard cost and no further calculations are made, so far as individual castings are concerned.

Elements in Floor Molding

Level floor
Place bottom board
Place drag
Strike off
Place board
Clamp
Roll over
Remove clamp and board
Make joint
Place cope
Remove cope
Close mold.

Unit of measure: Area of top of flask (by class of joint).

Place pattern. *Unit of measure: Per piece (by class).*

Shovel and ram. *Unit of measure: Cubic inches of sand (by class).*

Set gaggers. *Unit of measure: Per piece.*

Draw pattern
Finish
Blacken

Unit of measure: Area of pattern (by class).

Set cores. *Unit of measure: Per piece (by class).*

Final clamping. *Unit of measure: Per clamp (by class).*

Other elements include miscellaneous items to cover the following: Bolt and unbolt bottom plate; fasten pattern to cope; dry wet blackening; build runner box; rap pattern through cope; draw pattern pins; set nails; place wedges between cope bar and core print; carry off vent with rod, clay and cinders, etc.

Prevents Losses

(*Concluded from Page* 36)

the writer is not unmindful of the doubt that will be expressed by many readers. Nevertheless, in spite of the extra labor and the expense of increased flask equipment, he holds to the opinion that this method will produce more sound castings than any other, and at a lower cost.

"No mention is made of risers in the three methods illustrated in Figs. 104, 105 and 106. This feature will depend on the shape and size of the castings and is a point to be decided at the discretion of the individual foundryman. Personally, the author would favor risers on the castings molded and poured as shown in Fig. 106.

"A minor objection advanced by some foundrymen is in relation to the removal of the gates and runners. The objection applies particularly to nonferrous castings which have to be sawed from the gates. A little study will show a solution, which is to saw through the runners first, then lay the castings on their sides and cut through the gates. Many nonferrous castings can be knocked as readily as gray iron castings from the gates.

"Snap flask molds cannot be expected to give results comparable with those of tight flasks. Stiff metal flasks permit placing more patterns on a plate with a greater factor of pressure resisting safety, than would be possible with snap flask molds even where jackets are used."

Readers of the first article in the present series will remember that attention was directed to the meritorious features of small gates and high heads.

This is the nineteenth of a series of articles dealing with the various types of gates and risers used in the foundry industry. The twentieth will appear in an early issue.—THE EDITORS.

Foundry operations at the beginning of October in the Chicago district had made barely perceptible gains. Casting schedules remain at about 25 per cent. Several aluminum foundries had increased schedules slightly.

Committee Studies Standards for Manhole Castings

By L. B. Fish

DISKS of cast iron dotting the pavement here and there are such commonplace things that most people do not give much thought to them or realize the great number of differences in shape, size, and design that exist at present. The most surprising thing about these cast iron disks, which with their supporting castings are referred to generally as manhole frames and covers, is that there are literally thousands of different types and sizes of frames and covers in service today. In one city along having a population of about 500,000 it is estimated that there are at least 100 different types and sizes in use. A single foundry in another city reports that it has about 2000 different sets of patterns for manhole frames and covers and nearly 600 of these sets of patterns are listed as being active at the present time.

Lack Standardization

This great diversity in types and sizes of castings used for the same general purpose is due to a number of causes but principally to lack of standardization. Even in the matter of such a simple detail as the size of the opening there has been no attempt heretofore to adopt a range of sizes that could be used satisfactorily throughout the country as a whole for various purposes.

The great majority of these differences in type and size cannot be justified on any logical basis. Some of the manhole covers in use today are square while others are rectangular; many of them are round and some have been noted that are elliptical in shape. A still further variation in the general shape can be found in the rectangular or square covers which are made with the corners rounded to an appreciable radius. In each of the general shapes a great many different types and sizes have been produced owing to different ideas in regard to details of design such as ribbing, holes for lifting hooks, dimensions, and pattern of the top of the cover. All this has resulted in numerous designs, which not only are ill suited in many cases to the purpose intended but to foundry practices as well.

Obviously this is a field in which there is considerable to be gained through simplification and standardization. For example, breakage due to insufficient metal, poor quality of metal, and nonuniform distribution of the same could be eliminated; special core work and other increased costs of molding to care for unnecessary features, that have been introduced into what was previously a good practical design, would not be necessary; duplication of patterns and increased pattern costs where slight and unnecessary changes in design necessitate a new pattern would be things of the past; and waste of metal where castings are made too heavy would not occur.

In addition to all the advantages obtained through elimination of these undesirable features, the standardization of the relatively few necessary types and sizes would permit greater quantities of castings to be contracted for at one time and the consequent lowering of costs.

Inspection of manhole frames and covers is essential to insure that they meet the requirements of the specifications. With relatively few standard sizes this inspection work can be simplified and carried on at a minimum cost because the types would be practically the same at all foundries.

Considerable work has been done by the sectional committee which was organized a few years ago under the procedure of the American Standards association to take up the work of standardization in this field.

View Various Aspects

This sectional committee—whose work is jointly sponsored by the ASA telephone group and the American Society of Civil Engineers—is divided into six subcommittees, each one dealing with this problem from a particular standpoint. The division is mainly along the lines of the various fields of use for manhole frames and covers which are as follows: Sewer, water, gas, steam, and air; electric light and power; electric railways and steam railways; communication systems. In addition there is a subcommittee on specifications and inspection, and a correlating committee, the latter having been formed to consider the various types and sizes recommended by the other subcommittees with a view to reaching an agreement in regard to the essential features and to co-ordinate and simplify the various details in order that the number of types and sizes might be reduced to a minimum. Tentative specifications and drawings have been prepared covering the types and sizes for which there seems to be a general need at the present time, and it is the intention to have these tentative specifications and drawings widely disseminated in the near future for the purpose of obtaining comments and suggestions from municipalities, utilities, manufacturers, and others who are interested in this project.

The proposed designs were arrived at by each subcommittee of the sectional committee recommending the types and sizes that seemed to be necessary in the particular class of work which it covered. These recommendations were later studied by the correlating committee and the number of types and sizes reduced to a minimum. The work has been carried on along the lines of retaining in so far as practicable those fea-

(*Concluded on Page* 56)

Variation Is Large

STUDY of the dimensions of the various parts of the innumerable types and sizes of manhole frames and covers seems to indicate that each purchaser must have something different than his predecessor. There is no logical basis which justifies the majority of differences in sizes and types, and a simplification and standardization of the latter should be beneficial to both producer and consumer. The data presented in this article is abstracted from one appearing in the September Bulletin of the American Standards association. The author is associated with the American Telephone & Telegraph Co., New York.

Increases Production with Handling Equipment

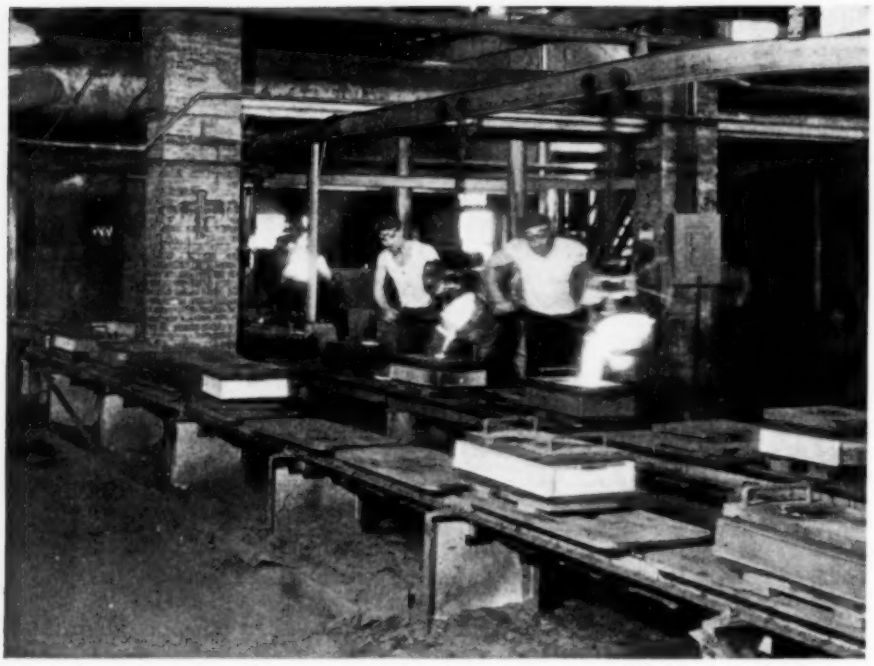


Fig. 1—The Conveyor Traveling 27 Feet Per Minute Carries the Molds Through the Pouring Zone, Located Near the Cupolas

AN INTERESTING contrast in manufacturing methods is afforded at the foundry of the American Seating Co., Grand Rapids, Mich., through the installation of complete sand and mold handling equipment. Radical changes in the practice at that plant have permitted an increase in production with a marked decrease in the cost per ton of castings.

The American Seating Co. is one of the oldest and largest manufacturers of school, theater and church furniture. The company specializes in an especially high quality product, and for that reason, uses a large quantity of gray iron standards in the construction of the various types of seats. The general layout of the plant before the installation of the handling equipment, and the procedure followed in the shop were described in detail in the Feb. 15, 1929 issue of THE FOUNDRY. At that time, the foundry was housed in a building 150 feet wide and 226 feet long. Molds were made on the floor, at benches and on machines, and each molder was required to catch his own metal from the cupola and carry it to his floor. The company operated 35 hand floors, 7 hand bench floors and 13 machine floors. The hand floors produced castings for middle and end standards, for theater seats and miscellaneous work and practically all work in that department was made in hinged flasks.

Five years ago when all of the work was made on the floor, the average production for each molder was 125 molds per day. Later when the molding machines, previously referred to, were installed and other improvements in operations were made, it was possible to step up the average production to 325 molds per man per day. With intermittent operation, that seemed the maximum that could be reached, and at the beginning of 1929, when the previously published article on the plant was prepared, those in charge of the foundry were planning for the time when further mechanization could be undertaken.

By installing complete mold and sand handling equipment, especially designed to meet the particular needs of the class of castings produced, it has been possible to place the foundry on a continuous operating basis. Within a few months after the new equipment was placed in operation, the average production had been increased to 550 molds per day per molder, and further increases are believed possible by the management.

The new unit consists of sand and mold handling equipment sufficient to serve 14 molders. The mold conveyor is of the sliding tray type, and is con-

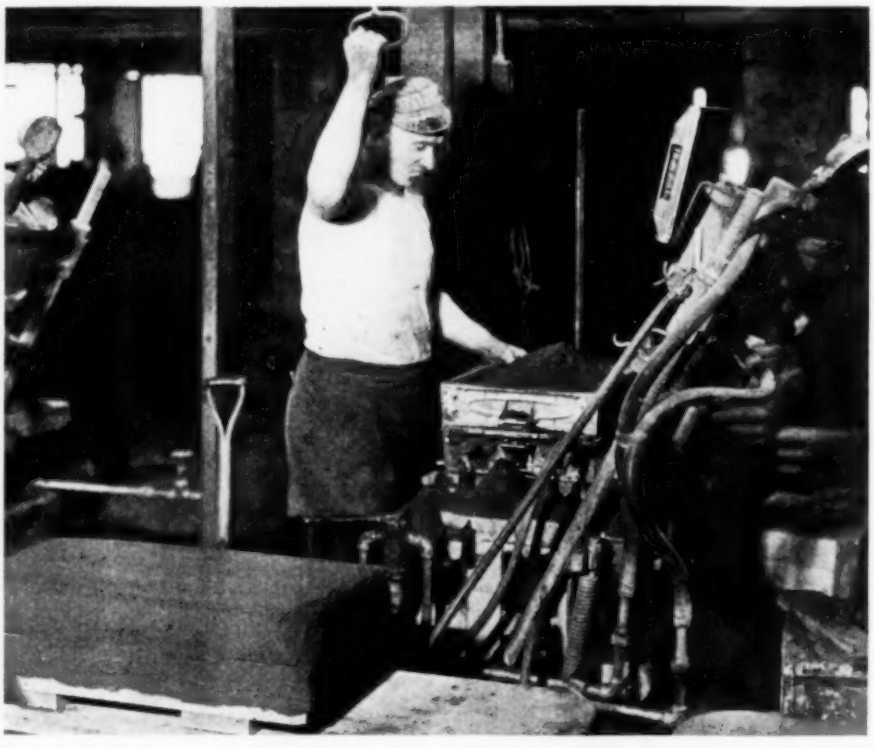


Fig. 2—Sand Drops Into the Flask on the Molding Machine When the Operator Pulls the Handle Above the Machine

sidered rather unusual in that it turns at right angles to the line of molders, giving what is considered a maximum cooling time in a minimum space and placing the pouring zone extremely close to the cupola. A view of the right angle turn is shown in Fig. 3, the pouring zone is illustrated in Fig. 1 and the shakeout is shown in Fig. 4.

Fourteen molding machines are located along the conveyor line. All molds are made in snap or taper flasks and the molds are loaded onto the machine as soon as they are completed, as shown in Fig. 2. As the molds move near the pouring zone, jackets and weights are placed as shown in Fig. 1, and the molds are poured, three men making up the pouring crew. Pouring rigs, made by the Modern Pouring Device Co. division of the Modern Equipment Co., Port Washington, Wis., and carrying 150 pounds capacity ladles, operate over an I-beam loop to carry metal from the cupolas to the pouring station. Each man in the pouring gang fills his own ladle from the large ladle under the cupola spout, and pours directly into the mold.

Two or three men are required to shift the weights and jackets from the molds that have passed through the pouring station to those just entering. Due to the design of the unit, this consists of a shift of only a few feet. One man dumps the molds on the vibrator shakeout, and a second, stationed at the shakeout, knocks off the gates and loads the castings and sprues on trucks, as is shown in Fig. 4.

The sand, after being separated from the castings on the shakeout riddle, is discharged onto a shakeout belt conveyor and is carried to the elevator. The elevator raises the sand and discharges it onto a magnetic belt conveyor, where such refuse as shot, sprue, etc., is removed. The sand is then passed through a revolving hexagonal screen which breaks up the sand lumps and separates the sand from cores and foreign matter which cannot pass through the screen. The sand passing through the screen goes directly to the large, 60-ton storage bin.

The storage bin is equipped with an adjustable table feeder loading an inclined tempering belt on which water is added by a spray. From the tempering belt the sand is dumped into a double paddle mixer or pug mill, which mixes and blends the molding sand. The sand then is passed through a revivifier for aerating. After leaving the revivifier, it is carried on a cross belt to a distributor belt, from which it is plowed off at the hoppers of the various molding machines. The sand drops from the hopper into the flask when the molder pulls on the lever, as shown in Fig. 2.

The layout of equipment was developed by George Roderick and James Ver Meulin of the American Seating Co. and engineers of the Link-Belt Co., Chicago, and the equipment was built by the latter company.

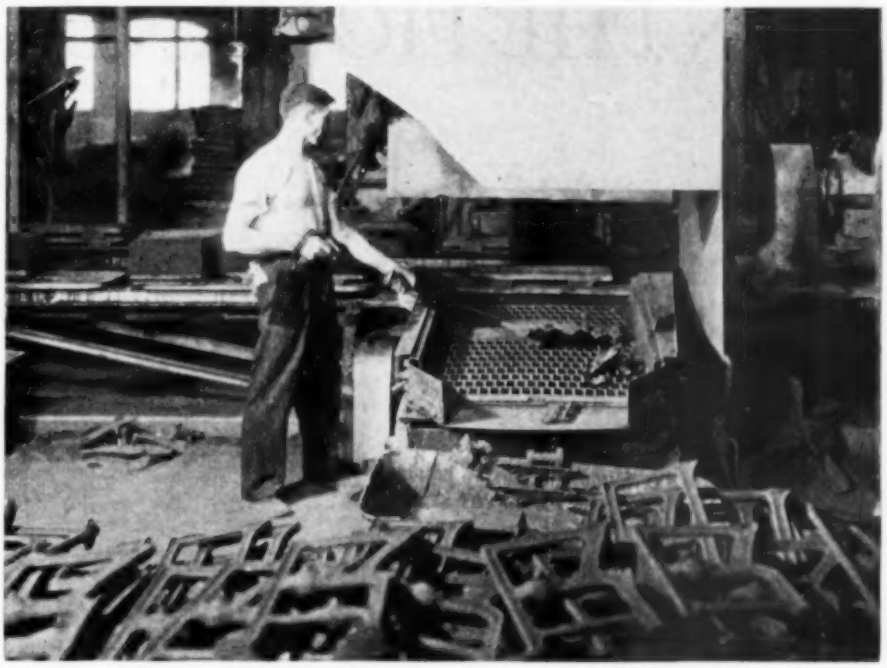


Fig. 4—The Molds Are Dumped on a Vibrating Shakeout. One Man Knocks off the Gates and Loads the Castings into Trucks

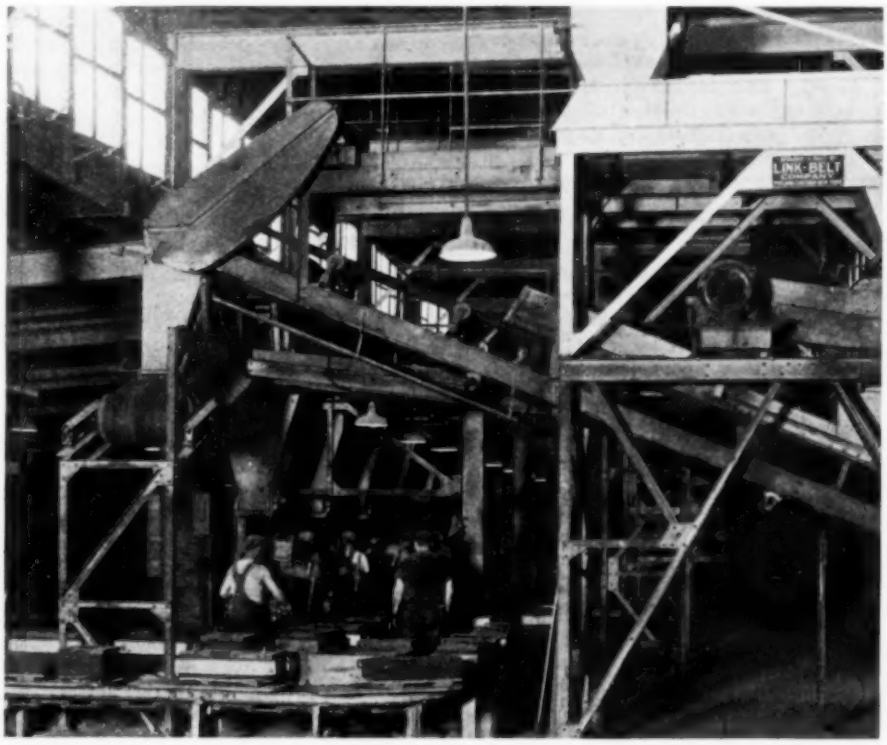


Fig. 3—The Mold Conveyor Makes a Right Angle Turn To the Line of Molding Machines To Reach the Pouring Station

Examine Metallurgists

Examinations are to be held by the United States civil service commission for the positions of associate metallurgist and assistant metallurgist. Applications for the positions must be on file with the commission at Washington, not later than Dec. 30, 1931. The examinations are to fill vacancies in the departmental and field services.

LaMonte J. Belnap has been elected chairman of the executive committee of the Worthington Pump and Machinery Corp., Harrison, N. J. and Harry C. Beaver, formerly vice president, has succeeded Mr. Belnap as president.

Clay and Sand Properties Play Important Part in SYNTHETIC SAND MIXTURES

By N. J. Dunbeck

CLAY bond may be applied to sand used in gray iron foundries in several ways. It may be added in the facing sand, which usually consists of old molding sand, a small amount of bond, seacoal and some sharp sand. The sharp sand is added to keep the sand open and to keep up the volume of sand in the shop, replacing the sand which is carried away on the castings. Clay may be added directly to the heaps in dry form but it must be mixed thoughly. A better and economical way is to make a slurry of the clay and distribute it over the heap before cutting it.

Mixer Is Used

The best method of rebonding a heap, where a muller type mixer is available is to make synthetic sand by adding bond to the refused and burned sand in the shop. This should be milled for a few minutes and then added to the heaps exactly as is new sand. In shops operating continuous systems, such a synthetic sand may be used regularly in place of new sand or a small amount of bond may be placed on each mold before it reaches the shake-out. Each shop presents different conditions and different methods accordingly must be employed. Whatever the conditions, the use of bond gives greater flexibility in adapting the sand to the castings being made and permits closer control of the two essential properties, bond and permeability.

The durability or life of a sand depends upon the rate at which the clay is dehydrated. When clay bond is used in facing, it loses only a portion of its strength when metal is cast against it. The remainder goes back into the heap and assists in keeping up the strength. Many foundrymen find that they need add no bond at all to the heaps or systems, since sufficient strength is given to them by the facing.

The production of synthetic molding sand in a foundry and the rebonding of used sand are essentially the same. In the first case, all new sharp sand and bond are used, in the second case, enough sharp sand is added to keep up volume. As the old molding sand gradually is carried from the shop on the castings, it is replaced by the constant additions of sharp sand, until, eventually, all of the sand in the shop has the characteristics of the sharp sand.

The best material to use for keeping up volume is burnt core sand, when an oil binder has been used. It retains much of its original characteristics in permeability and refractory qualities and has a slight priming coat on the grains, so that less bond is required.

The use of fire clay as a binder in steel foundry sands is an old, accepted practice. The present tendency is toward the use of better clays and reclamation of used sand. Because of the more destructive effect of steel on sand and the high premeabilities necessary, reclaiming has a more imporatnt place in steel than in iron foundries. Reclaiming systems are now on the market, that will yield a return of 85 per cent good sand from sand which was formerly carried to the dump. These systems are not necessarily elaborate and usually consists of a combination of screens and suction apparatus.

Because of the higher pouring temperatures in steel foundry operations, it is essential to use a more durable clay than in iron foundry operations. A clay which burns out fast may reduce permeability so that the addition of large quantities of new sand is necessary. In a reclaiming system, the weak dehydrated clay shells off the sand, and is carried away.

The first step in producing a synthetic molding sand is the selection of the proper base grain. A survey of conditions will indicate what bond, permeability and grain size are necessary. Synthetic sand may be manufactured in the foundry to meet any conditions encountered. Silica sand is selected from a consideration of refractory qualities and grain size Care must be used in selecting a sand, which will withstand high temperature without disintegrating. If cleavage lines are evident under miscroscopic examination, it usually will be found that the sand will break up along its lines of cleavage, and low permeabilities will result.

The next step is to select the proper bonding clay. Several factors must be considered. The clay must have high strength so that only small quantities are required, must give high permeability and leave only a small amount of inert residue in the sand. The clay must be as refractory as possible, that is, have a high fusion point. The more refractory the clay, the greater resistance it has to the metal at pouring temperatures and the cleaner are the castings. It must have a high vitrification point. A clay with a low vitrification point will fuse and flow at the temperature of the metal giving a rough, dirty casting. Such a clay will bake hard on to the surface of the casting causing a high sand loss.

Explains Durability

The clay must have long life or durability. Durability is resistance to dehydration or loss of strength through heating. The durability of the sand mass depends upon the refractory quality, the chemical constitution and physical structure of the clay; the refractory quality and grain size of the sand; and the temperature of the metal. The rate of cooling is important but it depends principally upon permeability and is a function of the sand grain size. The temperature of the metal is a reasonably stable factor. The other factors may be governed by selecting a clay with the requisite qualities for durability and by combining it with a sand of such

Tests Show Quality

QUALITY of both sand and clay used in the manufacture of synthetic molding sands, exerts an important effect upon the properties of those sands. Durability, refractoriness, strength and moisture retentiveness of those two components are important factors. A discussion of those points as well as descriptions of simple tests for several of the properties mentioned are included in this article which is abstracted from a paper presented at a meeting of the Ohio Foundries Association Inc., held in Cincinnati. The author is chief service engineer, Eastern Clay Products Inc., Buffalo, N. Y.

grain size as to give high permeability, thus decreasing the time of cooling.

A simple test will determine durability. A sample of clean silica sand is bonded with clay and used repeatedly. No additions are made except tempering water and loss in strength is determined after each pouring. Obviously, if one clay will continue to bond a sand two or three times longer than another, it is proportionately of more value and a rough approximation can be made of pounds bonding strength per dollar. Another beneficial feature is that during a fixed time, it will leave only one-half or one-third as much inert material in the heap. Another test, which has been developed recently, measures dehydration by direct heating, in successive steps, of the clay bond. After allowance is made for destruction of the carbonates and burning of organic matter, the further loss directly represents the loss in combined water.

Moisture Range Discussed

Clay must have a wide moisture range; it must maintain its strength to a reasonable degree even when overtempered or undertempered. Moisture will vary, depending on the human factor. The proper clay bond will aid in controlling this factor by giving as fool-proof a sand as possible. It is important, when testing, to check the *feel* of the sand at various moisture contents. Some clays reach approximately maximum strength and permeability at the best temper for molding. Other clays develop a much smaller precentage of their maximum strength when the sand is in proper condition.

The clay should distribute well through the sand Although various laboratory tests will indicate the total potential strength of the clay alone, a variation in its ability to distribute may reduce materially its actual strength Therefore it is necessary to test the sand-clay mix with one of the various instruments available A variation in mulling time gives much information on rapidity and completeness of distribution

Water in changing into steam expands 1600 times in volume When 3 per cent of water is driven off from a mold containing 100 pounds of sand, about 80 cubic feet of steam, measured at atmospheric pressure, are derived from that source alone. That factor becomes increasingly important in the light of recent work on hot permeability. The work shows that for a brief period there may be an actual back pressure in the mold with a greater tendency for the mold gases to penetrate the metal, than to escape through the sand. Any reduction in moisture content and consequent reduction in pressure must be of benefit in producing sound castings.

When a silica sand having a fusion point of not less than 3100 degrees Fahr. is combined with a bond having a fusion point above 3000 degrees Fahr. a mixture results, which is so refractory that it cannot be harmed by the temperature of molten iron. It literally falls away from the castings when they are shaken out.

Book Review

Chronology of Iron and Steel, second edition; cloth, 322 pages, 4 x 6¾ inches; published by Penton Publishing Co., Cleveland; supplied by THE FOUNDRY, Cleveland, for $4, plus 15 cents postage; in Europe by Penton Publishing Co. Ltd., Caxton House, London, for 20s 6d postpaid.

Since iron and steel play so important a part in the life of the world, their history from prehistoric times to the present is of great interest. In this volume, which may be slipped into the pocket, is compressed the leading facts of the development of this industry, chronologically arranged. presenting in accessible form the salient facts of the progress in knowledge and its application in a practical way to civilization's needs.

The original compilation was made by Stephen L. Goodale, professor of metallurgy at the University of Pittsburgh, and was edited by J. Ramsey Speer of the Massachusetts Institute of Technology. The second edition has been brought down to date by the Penton Publishing Co., taking the compilation through the first quarter of 1931.

The arrangement is chronological, from prehistoric eras through ancient, medieval and modern times, to the present. Thus is given a connected resume of developments from the days of Tubal Cain, indicating the gradual broadening of knowledge through the efforts of successive minds. An inclusive index makes possible immediate dating of any event.

This book forms a key volume in any library of iron and steel literature and is almost indispensable for the student or the general reader in this field.

Auto Output Drops

Production of automobiles in the United States and Canada during August totaled 191,741 units compared with 222,710 units in July, according to a report of the U. S. department of commerce, bureau of the census. Of the 187,197 vehicles made in the United States in August, 155,321 were passenger cars, 31,772 trucks and 104 taxicabs.

W. C. Bruton, formerly associated with the American Manganese Steel Co., Chicago Heights, Ill, as sales engineer in the Oakland, Calif., office has been appointed district sales manager for the Pacific Northwest territory comprising Oregon, Washington, British Columbia and the Coeur D'Alene district in Idaho.

Steel Founders List Meeting Dates

At a meeting of the board of directors of the Steel Founders' Society of America, Inc., held in Chicago, Sept. 16, the following meeting dates of that organizatioin were scheduled: Oct. 22, Roosevelt hotel, New York; Dec. 10, Hotel William Penn, Pittsburgh; Jan. 21, 1932, Chicago, the latter being the annual meeting.

At the same meeting, the following men were appointed to represent the society on joint committees of various associations: Fred Grotts, Hubbard Steel Foundry division of the Continental Roll & Steel Foundry Co., East Chicago, Ind., member, A.F.A. committee on specifications for steel castings, A.S.T.M. advisory committee on steel casting symposium and A.S.T.M. subcommittee VIII of committee A-1 on steel casting specifications; William J. Corbett, Fort Pitt Steel Casting Co., McKeesport, Pa., member A.S.T.M. committee A-1 on steel, and A.S.T.M. subcommittee on standardization, of subcommittee VIII of committee A-1; David Zuege, Sivyer Steel Casting Co., Milwaukee, member A.S.T.M. committee XXII of committee A-1 on specifications for valves, fittings, piping and flanges for high temperature service; A. S. Phelps, Pratt & Letchworth Co., Buffalo, member sectional committee A.S.A. on standardization of foundry equipment and supplies; R. L. Collier, Steel Founders' Society of America, New York, member A.S.A. sectional committee on manhole frames and covers.

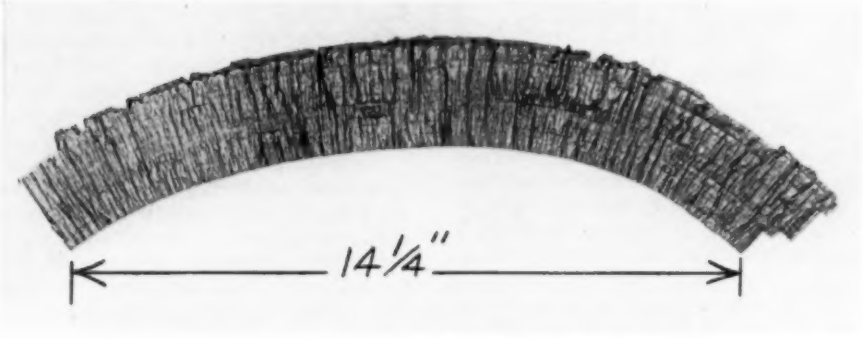
At a meeting of the cost committee of the society, a standard form of estimating sheet was tentatively adopted, which is based on the Society's uniform cost system and will later be published as a supplement to the uniform accounting and cost manual for Steel Foundries.

Discusses Gray Iron

Oliver Smalley, director technical department of the Gray Iron institute, Cleveland, addressed a meeting of the Detroit Foundrymen's association on September 17 in the crystal ballroom of the Fort Shelby hotel. Mr Smalley spoke on gray cast iron, discussing its constitution, specifications, physical properties in the light of recent research, engineering design and progress made in manufacture of superior irons. Special entertainment was provided following the address of the evening.

National development bureau, department of the interior, Ottawa, Canada, has published an illustrated booklet entitled, "The Province of Nova Scotia, Its Resources and Development." The booklet contains interesting features for the visitor and settler.

Zirconium Additions Affect Steel and Gray Iron



Turning Taken From a Zirconium-Treated Steel Casting

CONSIDERABLE interest has been aroused over the use of zirconium in steel and cast iron and its effects upon the properties of castings. Recent tests indicate that small additions of zirconium to castings greatly improve resistance to impact and hydrostatic pressure, and also increase the strength and deflection of the metal to some extent. Furthermore, there is a decided refinement of the grain structure resulting from the deoxidizing and denitrogenizing action of this element.

Impact Value Increased

Impact tests on two plain-carbon steels treated with zirconium show a marked improvement over two steels of similar analysis but in the untreated forms. One of the heats, analyzing 0.61 per cent carbon, 0.23 per cent silicon, 0.62 per cent manganese, 0.015 per cent phosphorus, and 0.019 per cent sulphur, and cleansed with ordinary ferrosilicon showed an Izod value of 12.0. This same steel, purified with zirconium-ferrosilicon showed an Izod value of 15.2, or an improvement of 26.7 per cent due to the addition of zirconium. Another steel, low in carbon and high in phosphorus and sulphur was analyzed as follows: 0.16 per cent carbon, 0.23 per cent silicon, 0.65 per cent manganese, 0.146 per cent phosphorus, and 0.047 per cent sulphur. Using ferrosilicon, the Izod values were 35.3 as against 46.0 with zirconium-ferrosilicon, or an improvement of 30.4 per cent when zirconium was added.

Several tests have been made of the physical properties of pearlitic manganese steels both with and without zirconium additions and with different methods of heat treatment. The studies covered three different steels, each having a different carbon and manganese content. Table I shows the results obtained from these investigations.

As may be noted from this table, those heats receiving heat treatment "A" merely were normalized and allowed to cool from 1560 degrees Fahr. Treatment "B" consisted of the usual quenching practice followed by drawing from slightly below the critical range. Treatments "C" and "D" were similar to "B," but the initial quenching operation was carried on from a higher temperature, while the drawing was done from lower temperatures and for a longer period of time.

Properties Are Improved

The results of these tests prove rathconclusively that the addition of small amounts of zirconium to this type of steel is beneficial in increasing the ductility and resistance to impact, and raising the elastic ratio of the metal. Table II shows the improvement resulting from zirconium treatment of the steels listed under Table I.

From the tabulation in Table II it will be noted that the properties are almost uniformly improved by the zirconium treatment. In a few instances one property, such as reduction of area, is somewhat reduced, but

Table I

Effect of Zirconium, Carbon and Manganese on Steel

			No Zirconium					0.10% Zirconium				
Heat number	Carbon %	Manganese, %	Heat treatment	Izod value	Elastic limit, lbs. sq. in.	Ultimate strength, lbs. sq. in.	Reduction of area, %	Elongation %	Izod value	Elastic limit, lbs. sq. in.	Ultimate strength, lbs. sq. in.	Reduction of area, %	Elongation %
409-A	0.52	1.15	A	15.0	58,700	118,500	53	18.5	.....	.....	.....	.....	.....
409-A	0.52	1.15	B	37.1	93,500	131,000	50	10.0	20.8	67,200	116,500	57.0	21.0
409-B	0.52	1.15	A	.....	.....	.....	....	.....	39.8	127,700	141,000	40.0	13.0
409-B	0.52	1.15	B	.....	.....	.....	....	.....	.....	.....	.....	.....	.....
413-A	0.42	1.34	A	25.3	65,000	114,300	48	19.5	.....	.....	.....	.....	.....
413-A	0.42	1.34	B	45.4	128,700	140,000	55	15.0	32.5	69,400	112,400	60.0	22.5
413-B	0.42	1.34	A	.....	.....	.....	....	.....	51.6	117,400	133,400	49.0	15.0
413-B	0.42	1.34	B	.....	.....	.....	....	.....	.....	.....	.....	.....	.....
414-A	0.27	1.50	A	26.6	49,700	101,300	46	20.5	.....	.....	.....	.....	.....
414-A	0.27	1.50	C	43.1	155,650	169,900	58	10.7	.....	.....	.....	.....	.....
414-A	0.27	1.50	D	61.5	126,650	136,650	62	14.0	46.2	51,400	100,300	56.5	22.5
414-B	0.27	1.50	A	.....	.....	.....	....	.....	45.0	156,550	167,400	56.0	12.2
414-B	0.27	1.50	C	.....	.....	.....	....	.....	67.7	121,650	131,200	63.0	16.5
414-B	0.27	1.50	D	.....	.....	.....	....	.....					

Heat Treatments:

A—Air cool from 1560 degrees Fahr.

B—Oil quench from 1500 degrees Fahr. (ordinary) and 1 hour at 1000 degrees Fahr.

C—Quenched from 1560 degrees Fahr. into oil at 525 degrees Fahr. for two hours, two hours at 752 degrees Fahr.

D—Quenched from 1560 degrees Fahr. into oil at 525 degrees Fahr. for two hours, two hours at 842 degrees Fahr.

a more than corresponding improvement of the other characteristics offsets this slight decrease.

Improves Gray Iron

Table III shows the results of further tests conducted on manganese steel, air cooled from 1500 degrees Fahr., and containing no zirconium, 0.10 per cent zirconium, and 0.20 per cent zirconium. It is interesting to note that slightly better results are obtained in most properties when 0.20 per cent zirconium is added than when 0.10 per cent is used.

It has been found that additions of zirconium to cast iron have as beneficial effect upon the metal as do similar additions of the alloy to steel. According to the late Dr. Moldenke, by far the most important effect is the refining action of zirconium on the structure to which he refers as the "closing up of the grain" of the cast iron. The many important improvements of the physical properties are a result of this refining action.

In a series of careful studies of the effects of various silicon alloy additions to cast iron, it was found that the addition of 0.25 per cent zirconium in the form of silicon-zirconium, containing 35 per cent zirconium, 45 per cent silicon, and 20 per cent iron, brought a remarkable change. The material treated in this manner presented a peculiar dark gray, velvety fracture indicative of great toughness. Subsequent impact tests proved this increase in toughness.

A further advantage derived from the use of zirconium is the increased resistance to hydrostatic pressure. An addition of 0.16 per cent zirconium as zirconium-manganese-silicon (58 to 62 per cent silicon, 10 to 12 per cent manganese, 20 to 24 per cent zirconium) greatly improves the hydrostatic pressure resistant properties of ordinary foundry iron. Whereas 800 pounds per square inch is considered unusually high for the maximum strength of a 12-inch gate valve casting, 900 pounds per square inch was attained with zirconium-treated cast iron before leakage occurred. In further tests on 8-inch globe valves, the ultimate pressure on a treated valve was found to be 2300 pounds per square inch, as against the usual figure of 1700 to 2000 pounds per square inch to produce leakage in an ordinary cast-iron valve.

In tests conducted at the Union Carbide & Carbon Research Laboratories, it was found that the addition of silicon-zirconium to a white-iron base effectively grayed the iron with resulting high-tensile and transverse strengths.

Substitute Can Be Used

As a result of the physical, chemical, and photomicrographic studies of zirconium-treated steel and cast iron, several interesting conclusions have been reached. Silicon-zirconium alloys may be used to advantage in acid steel castings which normally have a final silicon content of 0.30 to 0.40 per cent. By substituting zirconium-ferrosilicon for 50 per cent ferrosilicon to meet the final silicon specifications, there will

Table II

Improvement of Manganese Steel

WITH 0.10 PER CENT ZIRCONIUM ADDITION

Heat number	Carbon, %	Manganese, %	Heat treatment	Izod value	Elastic ratio	Reduction of area, %	Elongation, %
409	0.52	1.15	A	38.7	17.4	7.5	13.3
409	0.52	1.15	B	7.2	26.7	—20.0	30.0
413	0.42	1.34	A	28.2	9.0	25.0	15.2
413	0.42	1.34	B	18.8	—3.7	—10.8	0.0
414	0.27	1.50	A	73.5	4.4	22.9	9.7
414	0.27	1.50	C	4.3	2.1	—3.4	14.0
414	0.27	1.50	D	10.0	0.0	1.7	17.8

Heat Treatments

A—Air cool from 1560 degrees Fahr.

B—Oil quench from 1500 degrees Fahr. (ordinary) and 1 hour at 1000 degrees Fahr.

C—Quenched from 1560 degrees Fahr. into oil at 525 degrees Fahr. for 2 hours, 2 hours at 752 degrees Fahr.

D—Quenched from 1560 degrees Fahr. into oil at 525 degrees Fahr. for 2 hours, 2 hours at 842 degrees Fahr.

Table III

Effect of Zirconium on Air Cooled Manganese Steel

	A — No Zirconium							B — 0.10% Zirconium					C — 0.20% Zirconium				
Heat number	Carbon, %	Manganese, %	Impact value	Elastic limit in 1000 lbs./sq. in.	Ultimate strength, in 1000 lbs./sq. in.	Reduction of area, %	Elongation, %	Impact value	Elastic limit, in 1000 lbs./sq in.	Ultimate stgth., in 1000 lbs./sq. in.	Reduction of area, %	Elongation, %	Impact value	Elastic limit, in 1000 lbs./sq. in.	Ultimate stgth., in 1000 lbs./sq. in.	Reduction of area, %	Elongation, %
408A	0.41	1.52	18.8	61.4	117.0	45.6	17.0										
B								32.6	62.9	112.3	59.6	21.5					
C													34.0	61.1	110.2	57.5	20.5
411A	0.29	1.22	43.4*	57.8	92.3	63.8	27.0										
B								77.3	61.7	91.8	57.9	26.5					
C													78.0*	62.2	90.0	68.2	28.2
412A	0.24	1.61	33.0	48.8	95.4	56.4	24.0										
B								47.4	46.1	95.1	56.8	25.5					
C													55.8*	46.2	92.6	58.6	25.7
413A	0.42	1.34	25.3	65.0	114.3	47.7	19.5										
B								32.5	69.4	112.4	59.8	22.5					
C													22.8	62.7	114.8	62.5	20.5
414A	0.27	1.50	26.6	49.7	101.3	46.4	20.5										
B								46.2	51.4	100.3	56.5	22.5					
C													65.7*	54.6	93.8	63.1	24.5
417A	0.29	1.32	26.4	54.6	100.2	54.5	23.0										
B								41.2	53.8	98.5	55.4	23.5					
C													42.9*	54.7	97.8	57.7	23.6
423A	0.39	1.22	32.4	62.4	102.2	59.9	23.0										
B								45.4	59.7	99.8	61.8	25.5					
C													38.8	61.0	100.0	60.5	23.0
Percentage improvement by zirconium								56.8	1.4	—1.6	9.0	8.6	64.0	0.7	3.2	14.8	7.7

be an addition of one-third as much zirconium, or 0.10 to 0.13 per cent. This percentage of zirconium acts as a deoxidizer and denitrogenizer, and as a fluxing agent, increasing the tendency of the dissolved impurities to rise from the metal into the slag.

Analyses of the final steel show one-half or one-quarter of the nitrogen content in the treated steel as compared to that found in ordinary castings. Microscopic examination of zirconium-treated steel reveals a distribution of impurities irrespective of the grain boundaries, whereas aluminum-treated alloys usually show segregated impurities at the grain boundaries. This is particularly true of steel made by reducing silicon from the slag.

Zirconium also is valuable in counteracting high-sulphur content. Ordinarily the sulphur in soft steel castings is not sufficiently high to be detrimental, but in the production of acid-resisting castings containing high-chromium and nickel contents, many foundries include returned scrap carburizing boxes containing absorbed sulphur as part of the charge. The use of zirconium, particularly silicon-zirconium, is of great assistance in neutralizing the effect of this sulphur which cannot be eliminated in acid electric-furnace practice. Because of this, the presence of above 0.15 per cent zirconium prevents the hot shortness usually encountered in high-sulphur steels.

Increase Shock Resistance

Practice in some foundries is to use low-carbon, low-manganese steel with high ductility and low tensile strength for railroad castings which are subjected to repeated shocks in service. A higher manganese steel, treated with zirconium, would have the same resistance to shock in addition to the advantage of a high tensile strength. In some cases of heat-treated and rolled steels containing 1.50 per cent manganese, the increase in shock resistance is as much as 50 per cent.

Machinability also is increased through the use of zirconium because the steel has a more uniform texture and is free from hard spots or porous conditions. The illustration on Page 45 represents a turning originally twice this length which was taken from a zirconium-treated steel casting.

The test results indicate that zirconium affects cast iron in a manner somewhat similar to that of steel. Greater impact resistance and toughness, and a close-grained structure unusually resistant to hydrostatic pressure are assured. As has been mentioned, there is a marked deoxidizing and denitrogenizing action, and in addition a graphitizing effect on white iron with resulting increase in strength.

In general, the additions of zirconium to cast iron will vary from 0.10 to 0.30 per cent. The element should be added in the form of an alloy such as silicon-zirconium or zirconium-manganese-silicon because these alloys are absorbed more easily by the liquid cast iron than is ferrozirconium. In cupola practice the crushed material may be added to the cupola stream during the filling of the ladle in the same manner as chromium and nickel now are added.

The zirconium alloy addition usually brings in considerable silicon, and it, therefore, is advisable to keep the silicon in the cupola metal correspondingly low when such an alloy is to be added. Otherwise, the increased silicon content under certain conditions weakens the iron and masks the beneficial effect of the zirconium. The alloy addition occasionally makes the metal appear somewhat cold, but fluidity seems to be increased, so that castings will run well, and skulls are not as large as in normal practice.

Zirconium-ferrosilicon, which sometimes is used for steel castings, should be added to the metal in the furnace in all cases except that of basic open-hearth practice. If silicon-zirconium or zirconinum-manganese-silicon is used, it may be added to the stream during the filling of the ladle similar to the customary cast-iron practice.

Zirconium-ferrosilicon contains 12 to 15 per cent zirconium, 40 to 45 per cent iron, and 39 to 43 per cent silicon. Silicon-zirconium contains 35 to 40 per cent zirconium and 47 to 52 per cent silicon. Zirconium-manganese-silicon contains 20 to 24 per cent zirconium, 10 to 12 per cent manganese, and 58 to 62 per cent silicon. An addition of 8 pounds of the latter alloy to every 1000 pounds of metal will give a zirconium content of 0.16 per cent, a value considered suitable for such materials as valve castings.

The results of these tests indicate that the interest of metallurgists in the effect of zirconinum on steel and cast iron is well founded. The beneficial effects resulting from additions of this alloy are sufficiently important to suggest further attention throughout the iron and steel industry.

Moves District Office

The Birmingham office of the Independent Pneumatic Tool Co., Chicago, has been moved from the Comer building to 915 North Seventh avenue, Birmingham, Ala. The new location has warehouse facilities which will enable the district office to carry a complete line of pneumatic and electric tools as well as spare parts. H. F. Halbert is manager.

A report of the department of commerce shows that production of malleable castings in August reached 18,373 tons compared with 19,943 tons in July and that bookings for the two months were 18,305 tons and 19,400 tons respectively. The industry as a whole is shown operating at 18.8 per cent of capacity.

British Institute Meets in Switzerland

Through invitation of the Swiss Association for Testing Materials, the twenty-fourth annual autumn meeting of the British Institute of Metals was held in Zurich from Sept 13 to 15. The meeting opened with an official welcome in the Eidgenoessische Technische Hochschule which was followed by the tenth autumn lecture by Ulick R. Evans, Cambridge university, Cambridge, England. Mr. Evans' topic was "Thin Films in Relation to Corrosion Problems."

Technical sessions were held during the mornings of the second and third days while the afternoons were devoted to visiting plants in the vicinity of Zurich. Eight papers were presented on the morning of Sept. 14, and included "The Protection of Magnesium Alloys Against Corrosion," by H. Sutton and L. F. LeBrocq; "Nickel-Copper Alloys of High Elastic Limit," by L. B. Pfeil and W. T. Griffiths; "Unsoundness in Aluminum Sand Castings; Pinholes—Their Causes and Prevention," by D. Hanson and I. G. Slater; "Unsoundness in Aluminum Sand Castings: Effects of Using Metal Previously Subjected to Corrosive Conditions," by D. Hanson and I. G. Slater.

Seventeen papers were presented in the morning of Sept.15 which dealt mainly with wrought ferrous and nonferrous metals and alloys. The papers included: "Application of the Spectrograph to the Analysis of Nonferrous Metals and Alloys," by H. W. Browndson and E. H. S. van Someron; "Brittleness in Copper," by Clement Blazey; "The Oxidation of Some Copper Alloys," by J. S. Dunn, and "The Copper Magnesium Alloys: The Equilibrium Diagram," by W. R. D. Jones.

Show Heating Progress

The Second International Heating & Ventilating exposition, to be held in the Auditorium annex, Cleveland, Jan. 25 to 29, 1932, under the auspices of the American Society of Heating and Ventilating Engineers, is being planned to show the progress and development which has been made in heating, ventilating and air conditioning.

Handle Crane Sales

W. P. and R. S. Mars Co., Duluth, have been appointed representatives of the hoist and crane division of Robbins & Myers Sales, Inc., Springfield, O., for the sale of electric hoists, cranes and trolleys in Northern Minnesota and Upper Michigan Peninsula.

Fuller Lehigh Co., 85 Liberty street, New York, has removed its Boston office from 80 Federal street to 49 Federal street. H. H. Leathers continues as district manager.

Questions & Answers on FOUNDRY PRACTICE

GRAY IRON

Produce High Test Iron

We have been using flasks in our foundry made of malleable cast iron and also cast iron flasks which we make from our regular cupola iron that contains 2 per cent silicon 0.10 per cent sulphur; 0.60 per cent phosphorus, and 0.50 per cent manganese. The flasks are about 3 inches deep and range from 24 to 40 inches long, and 18 to 24 inches wide with a dividing bar down the middle and light cross bars. The cast iron flasks break easily, and those of malleable cast iron get out of shape. We believe that a high test cast iron would give us better results and would like some information on a suitable composition. We have a gas-fired furnace available that we could use to as a duplexing or refining unit for the cupola iron.

High test gray irons in the cupola usually are made from high steel mixtures containing from 75 to 90 per cent steel scrap with suitable additions of ferrosilicon, ferromanganese, etc. to give the desired percentages of those elements in the final iron. The large amount of steel scrap when melted properly lowers the total carbon appreciably, and makes a stronger iron.

However, with your shop operating on a production basis, it probably will not be possible for you to make a special charge or two for making flasks. While you do not state the type of gas furnace available, we assume that it is an open-flame type holding from 500 to 1000 pounds. If such is the case, you will be able to reduce the total carbon content of your cupola iron by mixing in steel scrap with the molten metal, and raising the temperature to the desired point with the gas furnace.

It is suggested that you turn on the flame of the gas furnace, and get the interior of the furnace white hot. Then charge the furnace with 20 per cent steel scrap and immediately pour in the remaining 80 per cent of molten cupola metal. Allow the scrap to dissolve, which should not take long, stirring the bath to determine when the scrap is dissolved. Raise the temperature to as high as possible, and tap out. If the metal is too hot allow it to cool without adding cold scrap.

However, one caution is urged. The suggested composition will give gray iron containing about 2.90 per cent total carbon with the cupola iron containing 3.54 per cent total carbon, and low total carbon iron will have to be poured at a higher temperature than your usual practice. It also may be necessary to work your sands dryer, and to see that they are refractory and open.

Rough calculations show that using 20 per cent steel scrap and 80 per cent molten cupola iron of the composition mentioned, the iron turned out from the gas furnace will contain about 1.40 per cent silicon; 2.90 per cent total carbon; 0.50 per cent phospohrus, and 0.45 per cent manganese. The silicon content may be a little low for making flasks, and you can adjust that by adding a little ferrosilicon to the bath if you find it necessary.

We also suggest that you study two articles appearing in the July 1 and July 15 issues entitled "Outlines Methods for Making High Test Gray Iron in the Shop Making Machine Tool and Jobbing Castings," by L. M. Sherwin and T. F. Kiley. The articles give considerable information not only on the mixtures used, but also cupola manipulation and pouring practice.

THIS department covers all problems relating to metallurgical, melting and molding practice encountered in making steel, malleable-iron and gray-iron castings. Questions submitted by bonafide subscribers to this department will be answered by members of the editorial staff of The Foundry, supplemented where occasion requires by the advisory staff whose personnel is as follows:

John H. Hall
Cast Steel

H. A. Schwartz
Malleable Cast Iron

J. W. Bolton
Gray Cast Iron

All questions must be addressed to the Editor, The Foundry, Penton Building, Cleveland.

Q & A

Make Grinding Plates

Can you suggest a suitable cupola charge for heavy grinding plates 2 inches thick. These castings are not machined, but must be extremedly hard to insure a reasonable period of service.

In a general way this inquiry may be answered by the statement that any combination of materials that will yield the following approximate analysis will serve: Carbon, 3.00 to 3.25 per cent; silicon, 0.60 to 0.80 per cent; sulphur, under 0.10 per cent; phosphorus, 0.20 to 0.40 per cent and manganese, 0.80 to 1.20 per cent. However, many minor factors must be kept in mind and in all probability a compromise eventually will have to be effected so that the materials in the stock yard may be utilized without purchasing other materials.

You do not state whether the castings are to poured against a chill or against a sand face. Grinding plates usually are supposed to contain contradictory qualities, extreme hardness to withstand abrasion, and a certain amount of toughness or resiliency to resist pressure or shock. Highly satisfactory plates can be made from low silicon charcoal iron and return grinding plate scrap, or any similar type of scrap. An all steel scrap charge can be used if the silicon and manganese contents are adjusted by ladle additions. A mixture of approximately one-third malleable scrap, one-third steel scrap and one-third low silicon

pig iron, with 1 to 3 per cent ferrochromium added in powdered form in the ladle might meet your requirements. If the face of the mold is chilled, a charge made up entirely or almost entirely of car wheel scrap will serve your purpose. What you want is a hard strong iron, presumably chilled to a depth of 1-inch or more and this may be secured through a number of combinations, including the foregoing.

GENERAL

MachineManholeFrames

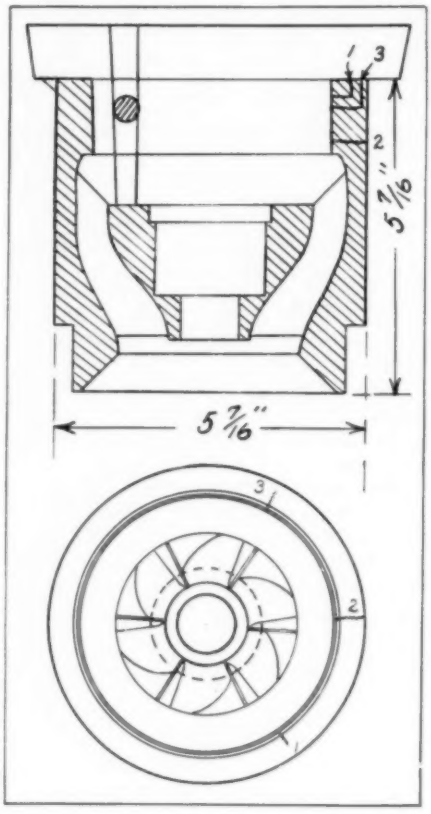
We shall appreciate any information you can give us on the methods and equipment employed for machining manhole frames and covers.

With the exception of a grinding machine introduced several years ago by a southern foundryman, we know of no special machines or methods for effecting a close and accurate fit between the adjoining surfaces of manhole and cover castings. The comparatively small number of castings subjected to a machining operation are handled on a boring mill in the usual manner. With good pattern rigging and careful molding methods these castings usually may be assembled without any necessity for machining. In some foundries a chill is employed to form the seat in the ring. In others a dry sand core is employed for the same purpose. Wood patterns, particularly cover patterns, are the most prolific cause of the misfit between ring and cover. It is practically impossible to secure a perfectly flat cover casting from a wood pattern. The wood warps and twists under the influence of the moisture in the sand. In some instances the warpage is only slight, but it is sufficient to prevent the cover casting from lying snugly in the manhole frame. A weight passing over will cause the cover to wobble perceptibly.

Q & A

Casting Cracks on Top

I am enclosing blueprint of a small pump casting that is causing considerable trouble. We cast these two in a flask in green sand and with the interior formed by a dry sand core made from sharp sand and oil. The core is kept as soft as posible and contains only a few light wires. The casting is poured through a small pop gate on the hub and as they are poured all through the duration of the heat, some are poured with hot iron, some with iron that is not quite so hot and some with iron that is just hot enough to run the vanes. Iron shows the following average analysis: Silicon 2.47 per cent, manganese 0.80 per cent, phosphorus 0.45 per cent, sulphur 0.07 per cent, total carbon 3.44 per cent. A small amount of steel scrap, 5 per cent, is added to each charge. After the heat is over all the castings are shaken out and taken to the cleaning room. Cracks and checks appear at the open or top end of the casting. Some of these checks are almost invisible, while other are quite distinct. Some run clear through the rim while others only extend part way, leaving from ⅛ to ¼-inch solid metal on the outside. Some castings show only one crack, while in extreme cases the casting presents as many cracks as vanes. The particularly aggravating feature is that in many instances these cracks cannot be detected by the naked eye, by a hammer or bell test, and only appear after the casting has been partly machined.



Several Gates Instead of One With Rapid Pouring Are Suggested

From the information which you have sent we are at a loss to determine if the cracks are vertical or horizontal. Your problem is interesting and may be subject to several solutions, but from the data submitted we are inclined to the opinion that all your troubles will disappear if you pour the metal faster, or rather fill the mold more rapidly than you have been filling it in the past. Instead of one small gate as shown on the blueprint sketch, place at least four of the same size on the hub, or preferably two of a larger size, and then pour hot iron into them rapidly. A shrinkage or contraction check appears on the outer or greater circumference. Yours sometimes appear on the inner side and sometimes do not show either inside or outside, but only appear after a cut has been taken from the surface. The defect has all the earmarks of a cold shut and can be cured by large gates and hot iron. Some experimenting will be necessary on your part to determine the proper size of gates.

STEEL

Plant Outlay Is High

We now are operating a gray iron foundry, and we would like to know whether it is practicable to manufacture steel castings. Can we melt in a cupola? We will appreciate any information you can give us on making steel castings.

Production of steel castings will have to be conducted in a department separate from your gray iron foundry and with its own organization. Raw materials, sands, etc. will have to be stored so that they will not get mixed with materials for the iron foundry. Steel cannot be produced from the cupola alone, but it may be used in connection with a refining unit such as a converter, electric furnace or small open hearth to make steel.

Since you have had no experience in producing steel or making steel castings, it is advisable to obtain the services of a skilled steel foundrymman who is familiar with both phases of making steel and producing good castings. A first class man can advise you on the equipment needed and the approximate capital outlay required, and it may be well to state at this point, that the latter probably will surprise you.

First of all you will have to obtain a melting unit which may be a converter, open hearth or electric furnace. The first and last named units may be obtained in small capacity sizes, and perhaps are more serviceable for intermittent operation. With the converter a cupola will be necessary, and it is advisable to have a separate unit rather than try to use the gray iron cupola for steel also. In addition to the melting units you will need mold drying ovens unless you intend to specialize in green sand molding. However, some castings can be made only in dry sand molds, and the ovens will be necessary.

Sand containing at least 98 per cent silica will be required for molding due to the high temperatures involved. The sand has to be reconditioned by use of clay wash or special bonding clays, and to obtain the most uniform results, sand mixing machinery will have to be installed. Annealing furnaces also will have to be installed to heat treat the castings and give them the most desirable properties for a given composition.

So far only a few points on the equipment necessary have been mentioned. The actual making of the steel, and making the molds is too involved to be described even briefly, and we recommend studying Hall's *The Steel Foundry* which may be purchased through The Foundry.

Problems in Nonferrous Founding

By Charles Vickers

Gives Tablet Bronze

Will you give us a formula for use in making bronze tablets? Also we notice that some manufacturers state that their tablets are made of government bronze. Can you give use the formula for that?

One of the recognized alloys for statuary, tablets and bank fittings is composed of 90 per cent copper, 7 per cent tin, and 3 per cent zinc. Another contains 89 per cent copper, 7 per cent tin, 2 per cent lead and 2 per cent zinc. However, these do not possess qualities that outshine a number of other alloys that are used. We believe that an alloy composed of 90 per cent copper, 6 per cent tin, 3 per cent zinc and 1 per cent lead will make a satisfactory mixture for tablets. One and one-half ounces of phosphor-copper per 100 pounds of metal should be placed in the bottom of the crucible with the copper.

As far as we are aware there is no standard bronze, government of otherwise, for casting tablets. There is an alloy known as gun metal or government standard bronze which contains 88 per cent of copper, 10 per cent tin, and 2 per cent zinc, but its use is not confined to any particular type of casting. For work exposed to the elements, we believe that it should contain 90 per cent copper.

Q & A

Uses Lost Wax Process

We are interested in the lost wax process of molding and would like to know where we can obtain information on it.

The name of the lost wax process of molding is obtained from the fact that the wax pattern from which the mold is made is melted out during the process, and lost. In making the molds a wax pattern or figure is used. If the object is to be made hollow, a core is made and the wax is coated over the core. The thickness of wax will correspond to the desired metal thickness. In addition to the pattern, thin cylindrical wax rods or strings are used for the vents, and heavier pieces of wax form the sprues and risers.

The wax pattern with its vents, sprues and risers attached, is suspended in a suitable container, and a liquid mixture of plaster of paris, powdered brick, asbestos, or screened silicon carbide sand, poured around it. The mold is allowed to harden sufficiently, and then it is carefully dried beginning with a low heat. Then the temperature of the mold is raised gradually until it is red hot. During that process the wax is liquefied and is absorbed by the mold, and volatilized. The completed mold while still hot is placed in a flask (if small) and surrounded with sand which is rammed into place. Provision is made for sprue and riser connections from the sand mold to the plaster mold. The ramming up should be conducted as rapidly as possible to prevent the loss of heat. The metal should be poured while the mold still is warm.

More elaborate descriptions of the lost wax and French sand methods of molding statues may be found in the July 1, 1924 and Jan. 15, 1928 issues of THE FOUNDRY.

Q & A

Flux Holds in Lead

What kind of furnaces are used to melt lead bronzes? How are high lead contents held in the alloy?

Crucible, noncrucible or electric furnaces may be used for melting leaded bronzes. Where the lead content of the alloy exceeds 25 per cent it is advisable to use a flux to hold the lead in suspension, otherwise there is a tendency for the lead to segregate. Addition of 5 per cent tin is said to hold the lead in a 30 per cent copper-lead alloy, but over that percentage tin is likely to cause difficulty in holding the lead. To hold in the lead of copper-lead alloys, it is suggested that you use a flux composed of 85 per cent calcium sulphate, 10 per cent soda ash and 5 per cent common salt. Use from 1 to 2 per cent; adding part with the cold charge, and the remainder while the metal is being superheated. About 0.5 per cent roll sulphur also aids in retaining the lead in suspension.

Nickel also is used to hold the lead in high lead alloys. From 1 to 5 per cent in the form of a nickel-copper or other alloy is used.

Eliminates the Iron

Would you send us information in regard to a skimmer to be used solely for molten aluminum. We are experiencing trouble with our 94.6 per cent aluminum alloy containing copper, as the mixture shows a high rate of iron, and we think this is coming from the skimmer. Would you advise us if this is possible?

If the skimmer is used to skim off the pot, and to stir the aluminum and hold back the debris floating on its surface as in ordinary practice, we are unable to understand how more than the merest trace of iron could come from such a source. Aluminum alloys melted in an iron pot take up a small amount of iron, but this is not sufficient to cause any trouble. In fact some alloys used for crank cases contain up to 1.5 per cent iron with 8 per cent copper, and a little zinc is often found by analysis. If the iron is under 1 per cent in this alloy we doubt if it will be at all harmful, but that all depends upon what the alloy is used for. We can see readily how the iron could get into the aluminum if the latter is remelted material. It is in the ingots, and the remedy is a new source of supply.

Aluminum is an easy metal to handle in the foundry, as its behavior in sand molds is unequalled amongst metals, so long as its temperature is kept down to reasonable requirements. However, if in melting the pot is filled with cold metal, and then neglected until it reaches the temperature of a red brass, 2000 degrees Fahr., or more, it becomes a dangerous chemical substance. An iron bar put in to stir it will be devoured with avidity, and it will even attack the crucible. In that way we get high iron, and such inclusions as aluminum nitride and carbide, also a lower oxide of aluminum, black in color.

The alloy mentioned contains 5.40 per cent copper and it is suggested that you try the addition of 3 per cent silicon to the alloy. Eliminate iron by using virgin ingot. Should there be doubt about the iron, whitewash the skimmers with cream of lime to which has been added a little silicate of soda as a binder. Dry thoroughly before use.

Safety Program Cuts Accidents In Ohio Foundry

By A. D. Lynch

THERE is an easy remedy for the many accidents that occur annually in industry. The remedy is an awakened safety consciousness on the part of the workers. It is only within recent years that any one has recognized the significant fact that safety consciousness had not kept pace with development of machinery and processes in industry, and the general speeding up of transportation and all phases of living. Within a few years laws have been passed in almost every state in the union in an effort to curb accidents. Industrial commissions have been created to protect the worker and place the cost on industry. The National Safety council now is organized and is working through industrial organizations and state and municipal authorities to reduce accidents. Departments of safety and hygiene have been established in most states to devise codes for mechanical safety in plants and to assist in promoting safety education and training in industrial and community life. Through these organizations and statistics which they have obtained, it has been proved definitely that safety and accident prevention are problems of training and education, rather than of guards, hazards, speeds or laws.

Personnel Available

Any plant has available within its organization the necessary knowledge and experience to conduct an effective safety program without interference with operation and without additional expense for personnel. If any plant has in its management and personnel, managerial ability to conduct the business and mechanical ability to operate machinery, it has everything that is essential for a safety program, except the interest and desire to promote safety.

Every plant in Ohio must be safe mechanically. State code requirements and inspectors guarantee these things. If a plant is not fully in accord with code requirements or if there are hazards not covered specifically by code, it will be money well spent to conform to code and to remove hazards. Once a plant is reasonably safe mechanically, there is no other program of industrial relations that is easier to sell to the workers than safety. However, don't try, to sell it to them when there are glaring examples of failure to conform to state code or to guard evident mechanical hazards. If those conditions have been corrected and the management desires to eliminate accidents, the establishment of a safety organization is easy.

First assign some individual or committee the responsibility for a safety program. Give that man or group sufficient authority to organize whatever subcommittees the size of the plant requires and authority to promulgate and enforce any safety rules needed. Make known to the workers, management's interest in safety and solicit their cooperation. Show them the advantages of a safe shop, both to themselves and to the business. Make it clear that their voluntary co-operation and interest in establishing such a program is desirable but that failing to get it voluntarily, co-operation will be secured by discipline. Following those instructions, be sure that the safety committees use the authority given them. The management should not fail to uphold their decisions.

Judgement Is Required

This, of course, implies that safety committees should be composed of men of judgement, and that their program should be rational and their rules fair and enforceable. Men of this type can be secured from no better source than from among the foremen If they are inexperienced in safety work there are many sources of information from which plans and programs may be secured. The National Safety council, the state department of safety and hygiene, or any plant in the vicinity already conducting a successful safety program can help.

A plant instituting a safety program should realize the necessity of maintaining employee interest, once it is aroused and should endeavor to appeal to the contest spirit that is inherent in practically all men. The Ohio Brass Co., Mansfield, O., divided its plant into three groups or divisions according to departments and now has 31 departmental groups in a plant normally employing 800 to 900 people. That division was made to keep the number of departments and total number of people in the group as equal as possible.

A general chairman for safety and an assistant in the personnel department in direct charge of employment were appointed. Three division chairmen, one for each factory group, were selected from plant foremen. Those men were given all the data that could be secured from various sources and from the experience and results of other safety programs.

Groups Are Assembled

The workers were called together in groups, as already divided for the contest, and the facts and safety principles explained to them. Particular effort was made to have them understand that the management had already done everything it could to make the plant safe mechanically, but stood ready to do anything further that was practicable or possible if such things were called to its attention by the safety committee or any worker. It was explained that the management desired, and would insist on, the workers' co-operation in eliminating accidents, that only reasonable safety rules would be promulgated and that they would be enforced.

The general safety chairman with the three group chairmen constitute the general safety committee. Each group chairman forms a safety committee in each department within his group. Each department has a chairman, usually but not necessarily the foreman, and one committee man or woman for every ten employees in the department. Those members of the committees are workers and not assistant foremen or supervisors.

The company has avoided a large

Methods Outlined

TWO requirements are necessary for the conduct of a successful safety program. The management must be convinced of its feasibility and desirability and the co-operation of the workers must be secured. The details and organization of such a program conducted at the Ohio Brass Co., Mansfield, O., where the author is personnel director, are outlined in this article which is abstracted from a paper presented at the Toledo meeting of the Ohio Foundries association.

number of specific rules. Individuals may suggest rules and departmental committees or divisional chairmen may approve them or make suggestions of their own but the general committee approves all rules before they become effective. Rules have been passed against operating any machine without the use of the guards provided, for wearing goggles on certain types of work, against wearing gloves on certain jobs, etc. The most important rule of all probably is that every injury, however minor, must be reported to the plant dispensary. That was inaugurated to avoid infection from lack of proper care and also to give to the committees a complete record of all accidents happening in the plant. The difference between the minor and the major accidents is only one of degree.

Accidents Are Reported

Nurses in the dispensary list every accident reporting to them, and typed lists, with copies for the general chairman and division chairman are made. Once each week those lists are discussed carefully at weekly meetings of the general committee.

The general committe meets every week. The company doctor sits with the committee and every accident is reviewed. Each division chairman marks on the list, accidents falling in his group of departments and checks back with the foreman and the individual involved for cause and remedy to prevent recurrence.

Once each month the general safety committee makes a plant inspection. The committee goes in a group throughout the plant, inspecting each department with the foreman as a guide. That serves to keep plant conditions right, to keep foremen alert, and to impress the workers of the importance of the safety program.

During 1926, the Ohio Brass Co. had no safety program in the plant. However the plant was in a safe condition mechanically. That year 279 accidents causing loss of time from the job, 79 of which caused loss of more than one week, were experienced. During 1927 the company tried to reduce accidents by putting the responsibility up to the foremen but had no organized program. Accidents were reduced to 156 causing lost time and 45 of more than one week duration. In January 1928, the company started the program described and which has been in operation since that time. In 1928 20 accidents occurred causing lost time, 11 for more than one week; 1929, 10 causing lost time, 6 of which were for more than one week; in 1930 to December 15, 4 causing lost time; all for more than one week. That reduction of accidents in consecutive years proves that accident prevention is more a problem of training, interest, and cooperation than of guards or hazards.

At the end of the first year of the company's active safety program, the three division chairmen were retired from division chairmanship and three different foremen chosen. That practice is followed at the end of each year and will continue until all foremen have acted as group chairmen. That method of definitely binding foremen to safety principles and organized safety work, has proved of inestimable educational value in training foremen to safety work. Personnel of departmental committees is changed as far as practicable each year. That also helps to spread the knowledge of safety work and increase the number of people in the plant who have worked actively for safety. The general chairman has remained in charge throughout the program.

The general committee of 4 is sent each year as representatives to the meeting of the National Safety council. One member of each departmental committee is sent to annual meeting of the Ohio Safety congress. That stimulates interest and impresses a considerable number of employes with the importance of and wide spread interest in safety. It also gives them a chance to compare the plants program and results with those of other companies.

Actual experience shows that the results of an awakened safety consciousness indicate positively that accident elimination is a problem of interest, education and training and that there is such a thing as safety consciousness. When that has been established and when people in general have learned to think and act from such a consciousness, a material reduction in accidents and accident cost will be effected.

Czechoslovak Founders Meet in Brno

The Czechoslovak Foundrymen's association held its eighth general meeting in Brno from Oct. 10 to 12. The first afternoon the members and guests of the association attended the opening of an exhibition of ancient and modern founders' art held at the Moravian Museum of Industry. Later, the opening meeting was held in the Chamber of Commerce and Industry. Four papers were presented and discussed, and they included: "Foundry Coke," by Dr. A. Altman; "Refractory Material Used in the Foundry," by Prof. Joseph Matejka; "Foundry Graphite," by J. Cibulka, and "Standardization in the Foundry," by R. Molak. On Oct. 11 a general meeting was held in the morning followed by a technical session in which the following papers were presented: "Pattern Making," by Stephen Pospisil; "Gray Iron and Malleable Iron Mixtures," by Dr. G. Storek, and "Molding Sands," by Valentine Uxa.

The annual banquet was held in the Marble room of the Provincial house through the invitation of the Brno-Kralovo Pole Machine Works, Brno; Ceskomoravska, Kolben; Danek's Foundries, Blansko; First Machine Factory of Brno,Brno; Mining Society of Rosice, Zastavka; Ignac Storek Foundry Co., Brno, and Uxa Bros. Foundry, Brno. In the afternoon a visit was made to the Czek Technical High school, and in the evening, an entertainment was held at the Provincial house. The morning and afternoon of Oct. 12 were spent in visiting foundries in Brno and its vicinity.

Reports Production of Gray Iron Castings

Production of gray iron foundries during August was 48.8 per cent of normal, according to a recent report of the Gray Iron institute. This compares with 50.6 per cent in July and 62.8 per cent in August, 1930. New business in August was 39.2 per cent of normal compared with 45 per cent in July and 56.3 per cent in August, 1930. The greatest activity was experienced in the territory comprising the states of Wisconsin, Illinois and the area West of the Mississippi river and South to Mexico.

Opens Safety Drive

Speakers of the Ohio industrial commission have appeared on programs at district meetings held by the Ohio Foundries association in launching its six months safety campaign. Thomas P. Kearns addressed meetings at Toledo and Dayton, Harry L. Sain of the commission was a speaker at Toledo and Youngstown. Fred Lange of the Crosley Radio Corp. also spoke at Dayton.

Ohio foundries reported a total of 9012 accidents during 1930, 26 of which were fatal. Mr. Kearns told more than 50 foundrymen at a noon luncheon at the Miami hotel in Dayton. As result of 212,750 industrial claims being filled with the state last year the commission paid $14,000,000 to injured employees while independent insurance companies paid an additional $4,000,000.

The Ohio Foundries Association is conducting the campaign in an effort to reduce accidents and secure a lower state insurance rate next year. A. H. Kramer, president of the association, is general chairman of the campaign while Robert Hoierman, association secretary, is the managing director.

Gives Steel Statistics

Steel Founders' Society of America has published a booklet entitled "Some Statistics on the Steel and Alloy Foundry Industry" which contains tables and comparisons on the productioin and equipment of steel foundries in the United States and Canada.

BILL

By Pat Dwyer

Would Dry Molds With Waste Gas

IF YOU were idle tomorrow," I said to Bill the other night, "have you any idea of where to look for a job?"

"That's a rather sudden question," Bill pointed out reproachfully "but since you ask it in apparent good faith, without sinister motive of any kind, so far as I can make out, I'll give you one of those fair and civil answers you read about but rarely or never receive. I know at least 40 places where I should like to look for a job. Now if you had asked me if I had any idea of where to look for a job with any possibility of securing it—Ah, then indeed I should find myself up a tree.

"I think I made a tactical error when I devoted my youth to learning the foundry business. I am sorry now I did not learn to be a bishop. There's a field that is not overcrowded. You never see one of those stout fellas idle and you never see of one of 'em listing his qualifications in the want ads."

"A bishop?"

"Sure. Why not? The work is easy. The pay is good. The hours are short. You never hear of a bishop getting fired or laid off in slack times. However, I suppose it is too late now to start in learning the business. For a second choice I should like to be a country store keeper. A friend of mine in England sent me a copy of a sign that stood in front of one of these places for many years. Here, get an eyeful of this:

JEREMIAH BOTTLENOSE

Parish clerk and school master, Grocer and Undertaker respectably informs Ladies and Gentlemen that he draws Teeth without waiting a minute. Applies leeches every hour. Blisters on the lowest terms and physics for a penny a piece. He Sells Godfather's Cordials. Cuts corns, bunions. Doctors horses. Clips donkeys once a month and undertakes to look after everybodies nails by the year. Jews harps, penny whistles, brass candlesticks, frying pans and other musical instruments at greatly reduced figures. Young ladies and gentlemen learns their grammar and Language in the prettiest Manner. Also great care taken of their Morals and Spelling. Also Psalm singing, teaching the Bass Viol and all Other Sorts of Fancy works, quadrilles, polkas, weazles and all Country dances taught at Home and Abroad at perfection. Perfumery and Snuff in all its Branches. As Times is Cruel bad I begs to tell you that I has just beginned to Sell all Sorts of Stationery Ware. Cocks, Hens, Poultry, Pigs and all other Kinds of Fouls. Blacking brushes, Herrings, Coals, Scrubbing brushes, Treacle and Godly Books and Bibles. Mouse traps, brick dust, whisker Seeds, Moral Pocket handkerchiefs and all Sorts of sweetmeats including Potatoes, sausages, and other Garden Stuff. Tobacco, cigars, Lamp oil, Tea, Kettles and other intoxicating liquors. A Deal fruit. Hats, Songs, Hair oil, Pattins, Buckets, Grindstones and other Eatables. Corn and Bunion Salve and all Sorts of Hardware. I has laid in a large Assortment of Tripe, Dogs meat, Lollipops, Ginger Beer, matches and other Pickles. Such as Epsom Salts, Oysters, Windsor soap, etcetera. Old rags bought and Sold here and Nowhere else. New laid Eggs by me Jeremiah Bottlenose. Singing Birds kept such as Owls, Donkies and Parrots, Lobsters, Crickets. Also the stock of a celebrated Breeder. I teach Geography, Arithmetic, Acoustics, Gymnastics and other Chinese Tricks. God Save the King!

"Talking about odd jobs and foreign countries reminds me that I had a rather peculiar inquiry the other day from the secretary of a foreign steel foundry company. He wrote that his company was considering the advisability of attempting to use the waste heat from the open-hearth furnace to dry the molds in the mold drying stoves, situated a short distance from the furnace. Had I any experience with installations of this kind and did I think there was any danger of explosion in the flues if the method was adopted?"

"Rather an odd inquiry," I admitted, "I never remember hearing the point raised before. Perhaps the reason is because no one ever thought of building the ovens close to the furnace. An open-hearth furnace with its flues and checker chambers occupies a good bit of room and the stack always is located outside the building. The melting department and its personnel usually are regarded as an independent unit.

"However, with a properly constructed and insulated pipe or tube, I am inclined to the opinion that the waste gas from the furnace could be conducted to the oven and utilized to dry either molds or cores. What did you tell this citizen?"

"Well," said Bill, "I'll tell you. Although I have been around a bit and seen a few things here and there I lay no claim to omnicience. So far as my limited knowledge goes, no person—at least in this country—has installed a system for heating a mold oven with the waste gas from an open-hearth furnace, but that is not conclusive evidence that the job cannot be done. Perhaps some good reason exists for the non-application of such a system. I determined to do a little inquiring on my own account. I know a couple of lads who have been engaged in steel foundry work—in executive and consulting capacities—practically all their lives and determined to submit the question to them. What's the good of

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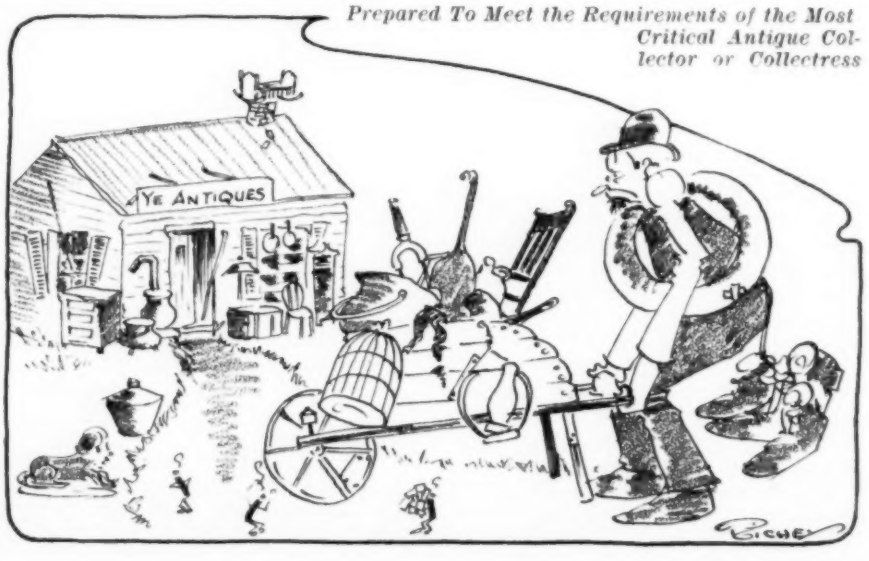


having an old pal if you can't bother him occasionally?"

"Are you telling me, or asking me?"

"Telling you, me lad. Telling you. A few days after I had sent out the clarion call for help, succor, assistance or what have you in three letters, I received a friendly letter from one old pal in which he admitted that up to the present his eagle eye had missed any, and his well trained ear had heard no account of a foundry where the waste heat from the furnace was utilized to dry the molds. Here, I'll read you his exact words:

I don't know of any foundry that has utilized the waste heat from its open-hearth furnace for drying molds. In a few cases, steel foundries have experimented in the utilization of this heat for pre-heating of the oil before it passes through the burners. In some installations, such waste heat has been utilized for generating steam in boiler plants. I believe something of this kind was done some years ago at the South Chicago works of the Illinois Steel Co.

It necessitates considerable expense to set up equipment of this kind and probably most open-hearth plants which produce the heat could better utilize it in generating steam than in drying cores or molds, especially considering the factor of transmission of the heat a considerable distance, which would often be

Long Words? He Can Sing 'Em!

required, in view of the remote locations of open-hearth furnaces as compared with core and mold ovens.

Of course, there is another factor in the intermittent nature of the heating operations in mold and core ovens. The waste heat from the open-hearth furnace is continuously produced. Such heat is not needed continuously for drying molds or cores. The intermittent factor does not exist in connection with ordinary steam boiler plants.

"That seems definite enough," I said, "How did the second old pal behave? As a true pal should, or otherwise?"

"And how!" Bill remarked quite enthusiastically. "His mileage is considerably greater than that of my first correspondent, but that may be set down to three main causes, to wit, as follows: Item 1—He wrote the letter on Sunday. Item 2—The idea of utilizing waste gas in the manner outlined has appealed to him on former occasions. Item 3—Believe it or not, he actually derives a certain form of pleasure from talking or writing and what may strike you as still more peculiar he makes a good job of either. Stand by to repel boarders! No, no, I mean stand by for station—Oh, well—Say, listen to this:

The question you have submitted is interesting to me because for many years I have held the opinion that steel founders operating open-hearth furnaces were missing a bet when they did not utilize their flue gases. However, I never yet have seen a steel foundry where this little pet scheme of mine could be applied without involving serious expense in moving either mold ovens or core ovens or both, into a location suitable for the application of flue gases as their heating medium.

I not only consider the scheme practicable, but I believe that in the conditions predicated by your correspondent, it is absolutely imperative to use the waste heat from the open hearth furnace.

The first thing to determine is the maximum temperature at the base of the present stack. This information will predicate certain details of the design of the projected drying ovens. Through varying systems of operation this temperature ranges from 800 to 1800 degrees Fahr.

If the maximum temperature of the waste gases at the location available for drying molds is higher than is admissible as a drying medium, properly located air inlets could be arranged to regulate the temperature in the delivery flue. Also a by-pass could be provided so that as much or as little as necessary of the waste gas could be drawn through the oven while the remainder entered the stack through the usual channel. These details readily could be arranged by a competent engineer.

The by-pass might be of the simple butterfly type at the junction of the two legs of the flue. The base of the Y of course, to be the main flue from the open-hearth furnace. One branch would lead to the drying ovens and the other direct to the stack. The air ducts would unite at a common chamber where a fan of adequate capacity at the mouth would deliver the air to the flue in proper volume.

The stoves should be under thermostatic control with the thermostat governing both the air fan and the butterfly valve. By setting the thermostat all the flue gases would be taken through the drying stove until the *trip* temperature was reached. At this stage the fan would commence to inject cool air and the butterfly valve would cut of part of the supply of flue gas. A drop in the temperature below the desired point would shut off the fan and readjust the butterfly valve controlling the hot gas.

You may be interested to learn

And Hot Cross Buns on Friday

that I have applied a somewhat similar principle to a core drying oven which you really must see next time you are in this vicinity. It is a simple arrangement governing an oil heater. Not a single core has been burned since the installation. The device insures the proper oxidation of the core oil and as a result the cores are delivered in a properly baked condition and not merely dried as is often the case.

Referring to the expressed fear of explosions taking place in the flues, I do not think there is much danger of an explosion in the flues, except possibly when the furnace is started. The buterfly valve leading to the drying stove should be kept closed during the heating of the furnace. The normal mushroom safeguard on the apparatus is sufficient.

However, as an added precaution, the flues leading to the stoves should be located near the floor level with explosion doors about 15 or 20 feet apart. The doors might be constructed of light steel plate and then covered with a thin layer of sand. In line with a general safety program it would be advisable to anchor the plate with a short length of chain to a spiral spring attached to a holding down bolt.

"With all this weight of learned opinion back of you," I said, "I suppose you wrote your foreign correspondent to go right ahead and install equipment for utilizing waste heat from his furnace."

"Well," Bill replied, "Yes and no. I wrote that I had no knowledge of any installation where the heat was utilized in that manner, but the scheme looked feasible to me. Here, I have a copy of my reply:

Personally I am inclined to agree with your idea of utilizing the waste heat from the open-hearth furnace

(Continued on Page 56)

Care and Materials Influence Cupola Lining Costs

CONTRARY to the belief of many foundrymen, the cheapest cupola lining to install is the most expensive ultimately. A cupola lined with the best block and properly taken care of should have to be relined only once a year, and often the lining lasts longer. When considering a cupola lining, also consider the patching material.

The life of a cupola lining depends to a great extent on the cupola man. If he knows how to mix the daubing material and lay his brick so that they will stay, he is sure to lengthen the life of the cupola lining. Cost of a cupola lining also includes the cost of patching each day besides the cost of labor used in lining and relining.

Gives Approximate Costs

For example, 1000, 24-cent blocks will cost $240. Other expenses include: The cupola man's pay, $9; helpers' pay $35; fire clay and daubing $5; fire brick $16; coke and wood for drying $10; a total of $315 for a lining that should last a year.

A cheaper block at 13 cents will cost $130 a thousand. Add the same labor and material cost as in the first instance, $75 and the total is $205. However, this lining has to be rebuilt at least three times a year, and that raises the cost to $615.

Patching cost of the best block will be about $1200 per year. The cost of patching the cheaper lining will be half as much again or $1800. The cost of a lining is based on the life, not just the cost of putting it in. Only a few bricks and some daubing are saved each day but the saving will be apparent at the end of the year.

In lining a cupola, lay the first course of blocks tight and level. Paint the inside edge with soft daubing. Pour some fire clay slush over blocks and rub in with the hand to fill all joints. Then lay the next course and squeeze them together with a bar. Pound the blocks down with a wooden block and hammer. Repeat on every course. That makes tight joints. Before moving the staging, brush down each finished section with fire clay slush. Fill all cracks made by the staging braces. The tighter the joints, the better the lining.

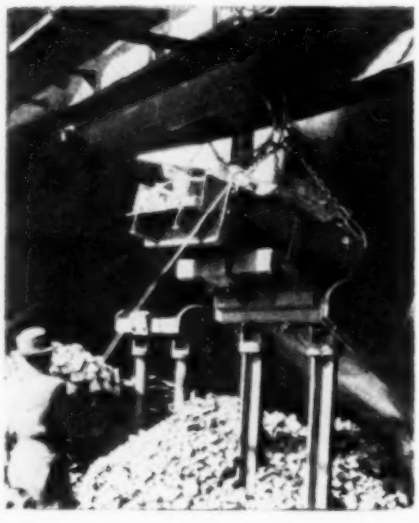
The bosh type lining finds favor in many foundries. This gives the bottom of the melting zone a thicker lining than it had formerly with a straight lining. From the melting zone to within 3 feet of the charging door there is no particular strain on a cupola lining. Around the charging doors there is a heavy strain because the usual charging crew seems to think it is necessary to knock the back out of the cupola to place pig iron around the edges.

Wear and attendant cost of repairing the charging zone can be prevented by the substitution of iron blocks for the usual clay blocks or bricks. An iron block lining extending from the top of the doors to a ring 2½ or 3 feet below the sill will save considerable repair cost in the charging zone.

The life of a lining depends upon the care it receives, how it is repaired, height of coke bed and intensity of the blast. The blast should be as moderate as possible. From 10 to 14 ounces pressure is sufficient for a 60-inch cupola. The cupola can be charged in a manner to operate between these two pressures with good results. A 42-inch bed is high enough where 1-ton charges are used. If the first is a heat-up charge of 1500 pounds of pig iron or light scrap, a 36-inch bed is plenty.

Charge Carefully

Where the material is charged carefully by hand, the pig is placed around the outside, steel in the center and scrap distributed evenly around. Large pieces are placed as near the center as possible and kept level with the rest. Coke is packed first around outside, then in the center to insure a level charged cupola. Limestone or other flux is placed as near the center of each coke charge as possible. With a 40 or 50-ton heat, the cupola lining should not burn in over 2 inches or 4 inches at the widest place in the melting zone.



Special Care Must Be Exercised in Charging the Cupola

Tuyeres should be level and evenly placed, and preferably continuous. The average 72-inch cupola has a 60-inch diameter inside the lining at the tuyeres. Allowing 1-inch thickness of metal in the tuyere casing it is apparent that if six tuyeres arranged to form a continuous tuyere, each one will measure about 29 inches across the face. Other dimensions will include a height of 5 inches at the face and an opening 6 x 14 inches at the shell. One bracket or support in the center of each tuyere is sufficient.

A cupola should slag freely. When once opened there should be no further need of touching the slag hole. The height of the slag hole above the sand bottom depends upon the length of the heat. With a small heat the hole may be kept higher than with a long heat. A slag hole 3 inches below the tuyeres will serve satisfactorily for the average heat of 40 to 60 tons. For a larger heat it is a good practice to drop the slag hole another ½-inch. On 1-ton charges 65 pounds of limestone is enough for fluxing. An extra amount may be needed on the bed, depending on how the slaghole is used. If left open, no extra limestone is needed.

The slag hole can be ⅛-inch larger than the tap hole and should be driven from the outside on an upward angle of 45 degrees. The pin for forming the slag hole should be tapered about 2½ inches to the foot. This form of slag hole permits the slag to flow freely and will stand up a long time.

Should Check Often

Check the melting zone after the heat and after patching and have blast gage checked. No cupola should be operated without an accurate blast gage. Blast control is one of the most important factors in cupola operation.

The sand bed should be checked and the wind box should be kept clean. The wind pipe should be soldered and air tight. Air circulation will be kept practically the same if these things are looked after daily. This all appears expensive but in reality means a saving. A good cupola man can effect savings in excess of his wages by careful observation and checking on coke, limestone, and other materials.

The FOUNDRY Family Photograph Album

Upper Left

F. F. ELLIOTT

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Upper Right

T. S. HAMMOND

Whiting Corp., Harvey, Ill.

Lower Left

WESLEY LAMBERT

London, England

Lower Right

HENRY FORD

Ford Motor Co., Detroit

Studies Standards

(*Concluded from Page* 39)

tures of design which have proved of value over long periods of service and the dimensions have been chosen with due consideration to those which are used in practice and have been found to be suitable. Furthermore, in reducing the number of designs and sizes the committee has probably erred on the side of not unnecessarily restricting the users of these articles, which seems most desirable in initiating a project of this magnitude.

The matter of simplification has been extended to the materials involved as well as to the designs and sizes, in order that the standards recommended may be obtained anywhere in the country and at a minimum cost.

Most of the manhole frames and covers that are in use at present are gray iron castings and, where designs are suitable and a good grade of cast iron has been furnished, the experience with such castings over long periods of years has been that they are satisfactory and economical. For these reasons the proposed specifications require gray iron castings for all sizes of manhole frames and all covers up to and including those for frames having openings of 30 inches in diameter in the clear. In the case of covers for the frames having openings in the clear of 33 inches, 36 inches, and 42 inches in diameter, which are required on account of the sizes of large transformers that will be installed in the manholes, cast steel covers are required in the proposed specifications in order to reduce the weight to a point where these large covers can be removed and replaced by the ordinary means employed for the smaller cast-iron covers.

In the matter of shape, the committee recommends that the openings in all manhole frames be round, which means the use of round covers. With the round frame and cover, less metal is required per unit area of opening than for any other shape, and the machining of the cover seat and cover is simplified. Furthermore, round covers can be handled with greater facility than square or rectangular ones and it is not possible to drop them into the manhole with the possibility of causing considerable damage. Flat covers are recommended in all cases because they contribute to smooth riding pavements and facilitate the operation of snowplows and scrapers in cleaning the pavement and shoulders of the roadway.

The diameters of openings recommended at present in the clear of the frames are as follows: 22 inches, 24 inches, 27 inches, 30 inches, 33 inches, 36 inches, and 42 inches.

The 22-inch size is a straight type of frame with a round base. In the 24-inch size which is a flared type of frame, there are two types, one with a round base or flange and the other with a square flange. The 27-inch and 30-inch sizes of frames involve twelve different types which are recommended to meet various conditions, such as round and square flanges at the base, shallow types to care for changes in street grade, light-weight types for use where there is no vehicular traffic, and the type with locking inner cover used where it is desirable to control access to cables and also to protect open cable splices from surface water. The 33-inch, 36-inch and 42-inch sizes are of the straight type with square flanges.

The height of the frame or the vertical distance from the top of the casting to the bottom of the flange varies from 1½ inches on the shallow ring for sidewalk use to 11 inches for the straight type of frame with inner cover, the provision of the latter causing this greater height. The intermediate heights are 5⅝ inches, 7 inches, 8 inches, and 10 inches, respectively, as required by the particular design of the casting.

Machining is specified for both the horizontal and vertical faces of the cover seat or rabbet in the frame and the surfaces of the cover that come in contact with these faces. This has been done to obtain an even bearing of the cover in its seat, which will prevent rocking, and thereby eliminate noise and much of the wear. By machining the vertical surfaces it is possible to obtain a close fit of the cover.

The proposed specifications and drawings cover thirteen types of frames and six types of covers caring for seven different sizes of manhole openings.

Bill on Drying Molds

(*Concluded from Page* 53)

by conducting it through the mold drying oven. Offhand I see no more reason for anticipating explosions in the oven flues, than in the regular flues leading from the furnace to the stack.

Unfortunately I have no knowledge of any installation of this kind, therefore while I am willing to approve the scheme, I cannot adduce any proof or quote any precedent that might add weight to my personal opinion. In none of the steel foundries which I can call to mind, was the melting unit situated close to the core and mold ovens. Perhaps that is the main reason why any attempt never was made to utilize the waste heat in these places.

Lack of elasticity in the proposed method of firing the oven, also may have been a contributory factor. At the beginning of each week, also on the day following any closed down period, it is conceivable that dried molds would be required on the floor in advance of the time they could be expected from an oven heated by waste gas from the furnace. However, it is possible you have in mind some form of auxiliary firing device to take care of hypothetical cases of that character.

You basic idea seems to be sound. I presume you have designed, at least tentatively suitable valve equipment for diverting the waste gas through the oven flues, or, into the regular furnace stack directly from the checker chambers, as desired. Certainly I shall be greatly interested in hearing further from you when and if you go through with the experiment.

Wisconsin Group Has Many Activities

The Wisconsin Gray Iron Foundry group, affiliated with the department of metallurgy of the University of Wisconsin, Madison, Wis., began its sixth year of activity with a meeting held Wednesday evening, Oct. 14, at the Hotel Schroeder, Milwaukee. Prof. Raymond Roark, department of mechanics, University of Wisconsin, discussed the "Effects of Machining and of Surface Defects on the Strength of Cast Iron."

Reports indicate that the increasing interest of the group membership and the activity of the committees have made the past year one of the best since the organization first was started. A fellowship was maintained in the department of metallurgy during the year. The committees of the group, aided by the facilities put at their disposal by the university, accomplished a large amount of work which has been reported to the members throughout the year. The work entitled "Modification of the Present A. F. A. Method of Clay Substance Determination" was prepared under that fellowship as one of the activities of the sand committee of the group. The report will be presented in an early issue of THE FOUNDRY.

The efforts of the Wisconsin Gray Iron Foundry group also have been recognized by other associations. The work of the test bar committee was reported to the committee A-3 of the American Society for Testing Materials and was considered responsible largely for the forming of a subcommittee on automotive castings, which will include the study of the smaller test bar for light castings.

During the past year the committee on the proposed regulations of the industrial commission applying to foundries attended the hearing of the industrial commission of Wisconsin and secured a postponement of the date for enforcing the commission's rules applying to foundries. The committee has co-operated in having a thorough technical and medical study made, to secure correct data to assist the industrial commission when the case comes up later.

What Others Are Thinking

Abstracts Selected from European Foundry Literature

Apply Rules for Speed

The Speed of Rotation in the Centrifugal Casting Process, by J. E. Hurst, *The Foundry Trade Journal*, London, Sept. 3, 1931.

Deals with conditions governing the movement of liquids under the influence of centrifugal force when rotated in containers around either a vertical or horizontal axis. An extensive series of formulas illustrates the method of arriving at the proper speed of rotation for any given size mold in feet or in centimeters. When a large mass of metal is poured into a mold rotating at a constant speed around a horizontal axis, the entire quantity of metal is not picked up immediately. As the temperature of the metal falls, more and more of the liquid steadily assumes the rotational movement. By slow pouring or the utilization of cold metal it often is possible to produce castings of exceptional radial thickness at a rotational speed lower than that which would be necessary with hotter metal. A table contains a list of rotational speeds which have been published by various authorities in relation to several processes.

Molds Cylinder

Execution of an Hydraulic Cylinder of 15 tons, (Execution d'un Cyliudre Hydraulique de 15,000 Kilos,) by M. Constant. *La Revue de Fonderie Moderne*, Paris, June 25, 1931.

Foundries which are not specially equipped to manufacture hydraulic cylinders occasionally may receive replacement orders. This article describes how a mold for hydraulic cylinders is prepared in loam. The article describes the preparation of the mold, the execution of the central core, and gives information relative to the pouring.

Sweeps for Oval Castings

Sweeping of Oval Molds (Schablonieren ovaler Formen), by Kurt Hoffmann, *Die Giesserei*, Duesseldorf, Germany, Sept. 4, 1931.

One of the first actions in sweeping up large oval castings, is to lay out mathematically the various radii from which the sweep is operated to give the desired elliptical form. That is accomplished from the working drawing by inscribing a small circle on the minor axis of the ellipse, and circumscribing a large circle on the major axis. Both circles touching the ellipse at the interceptions of the respective axes. A radius is drawn from the center of the circumscribed circle which intercepts the inscribed circle. A perpendicular is dropped from the point where the radius intercepts the outer circle. A line parallel to the radius is drawn through the point where the perpendicular intercepts the ellipse. The parallel line intercepts the minor and major axes of the ellipse, and the intercepts establish points for the construction of radii for making the ellipse. Sufficient number of radii are developed to give the correct contour of the ellipse. In sweeping up the mold, the radii developed are used with a device in the form of a cross. The cross has a pivot which is centered in the mold. The arms contain T-shape channels in which a bolt may be moved or locked into position. The upper end of the bolt serves as the point of attachment for the sweep arm. In use, the bolt is moved to a position in one of the arms which corresponds to a radius. The sweep arm is adjusted to the proper length, and the whole locked to prevent movement other than pivotal on the bolt. After describing the sweep movement, the position of the sweep is changed, etc. until the ellipse is completed.

Utilizing Molding Machines

The Best Utilization of Molding Machines (La Meilleuere Utilisation des Machines a Mouler), by A. Raucq, *La Fonderie Belge*, Liege, Belgium, August, 1931.

In a previous article the author described ramming the sand, and this covers the types of molding machines and the handling and transportation of sand, flasks, etc. to get the most out of a machine. For nonrepetitive work the advantage of a molding machine lies principally in the time and regularity of ramming, and an increase of 50 per cent may be obtained in a day's work. Efficient methods of preparing patterns and using them on a machine are given. Sand and flask transportation in relation to the class of work is discussed. Two simple continuous molding units are described. One uses flasks 23.5 x 37.5 inches and produces at least 40 molds. The other uses flasks 15.5 x 19.5 inches, and 5 men make and shake-out 300 molds in 8 hours. The time also includes that for preparation of sand and cleaning castings.

Outlines Cupola Operation

Operation of Cupolas (Conduits des Cubilots), by Guy Henon, *La Fonte* (bulletin of the Centre de Recherches de Fonderie), Paris, France, July, 1931.

A number of simple rules which have proved satisfactory in practice when applied to various cupolas of normal construction are presented in the article. The survey begins with the examination of the lining and goes right through the operation of the cupola, covering the composition of the charges, starting of the cupola, charging, control of the tuyeres, flow of metal, etc. The characteristics of a good melt are given, and a table outlines the various irregularities with their causes and remedies.

Studies Cause of Defects

Cast Iron, Its Qualities, Its Defects, (La Fonte de Fer, ses Qualites, ses Defauts), by L. F. C. Girardet, *La Fonderie Belge*, Liege, May, 1931.

This is the second of two articles on the same subject. The first dealt with graphite in cast iron. The second factor governing the quality of cast iron is of a two-fold nature, homogeneity and fineness of grain, which are related closely to each other. It is impossible to obtain a perfectly homogeneous material as cast iron is composed of one homogeneous phase in which liquid phases are included with at least one solid phase, primary graphite. This is an unavoidable cause of heterogeneity. In addition, the various components of the charge do not melt with the same speed and as those components arrive at the hearth, they form layers. To minimize the latter effect, the author has conceived a method which consists of giving the molten metal a rotory movement. The rotating movement also throws slag, etc. to the center of whirling mass.

The author then deals with the subject of corrosion resistant cast iron. Corrosion is explained by the electrochemical action between the metal and the corrosive liquid. Localized corrosion should be avoided by securing a cast iron with fine graphite distributed regularly throughout the mass. That factor also applies to cast irons of good mechanical properties. It is pointed out that it is ferrite which is attacked most easily. Additions of chrome, nickel, cobalt or copper are recommended to reduce that tendency.

Dealing with heat-resisting cast iron, it is stated that the mechanical properties of cast iron decrease materially at a dull red heat. However, the most important fact to consider is growth which is ascribed to the decomposition of cementite. To obtain the best heat resistance, graphite should be distributed finely and regularly and the grain should be homogeneous and fine.

Another factor intervenes in the case of heat resistance and that is stabilization of cementite. That can be accomplished by additions of certain agents which retard graphitization such as chromium, manganese, sulphur, etc. Encouraging results have been obtained with regard to the action of sulphur and the addition of 0 25 per cent vanadium. The action of silicon is peculiar and seems to be favorable between contents of 1.10 and 1.17 per cent, according to Donaldson. According to Levi, silicon will tend to decrease the amount of carbon, and consequently the tendency toward growth, at as high a point as 2 or 2 5 per cent. Kennedy and Oswald have found that the best results are obtained with cast irons containing 1.56 per cent of phosphorus when 0.25 per cent of ferrotitanium has been added to the ladle. Different methods should be used for specific cases.

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¶ Here's a Job To Be Done

NECESSITY for group action in attacking business problems is perhaps the outstanding lesson of the depression. The trade association, properly conceived and well managed has been a most potent force in preserving many industries from chaos during the period of low rate, profitless manufacture. The adherence of individual firms to their respective trade associations has been the mark of merit and the measure of worth of these groups. Organizations which have been established and operated upon the fundamental basis of bettering business conditions, conducting merchandising activities, unifying action on trade practice developments have been outstandingly useful in the depression period.

SPEAKING before a group of trade association executives last month, Frederick M. Feiker, director, bureau of foreign and domestic commerce, Washington, pointed the path of service. He said:

> In my opinion, a great opportunity faces organized trade groups at the present time in divorcing themselves from a purely legalistic relationship to the problems of business development and establishing themselves on the platform of a solution of economic problems.

Divorce from sporadic technical and production activities and from personnel and employment matters where such work is a duplication of effort already developed might also be suggested. The study of markets, trends, developments of consumer demand and better distribution constitutes the path of action of trade associations. In this necessary and important work active co-operation at all times between the useful trade organizations representing various branches of the foundry industry can be most effective in advancing the common cause of all.

¶ Junk Worn Out Measures

TWO ardent fishermen, Dumb and Dumber, had been angling all morning in a spot where they "pulled them in" with pleasing frequency. Resolving to return to the boat house for lunch, Dumb undertook to mark the spot so they could return and resume fishing in the afternoon. He opened his pocket knife and carefully notched the prow of the boat. "That's crazy," said Dumber, "How can we locate the place by that; we might not get the same boat." Foundrymen who are bidding on averages of past year's costs may be Dumb. But those who bid on their competitor's figures are Dumber.

¶ Evaders Will Be Few

WHEN the subject of firm bidding is discussed in any group, someone usually will have the snappy comeback "Yes, but how are we going to enforce the agreement?" The question seems logical, for it might be considered difficult, if not impossible, in the face of present selling practices, to get individual members of an industry to agree to submit a selling price accurately determined with reference to manufacturing costs, and then stick to that price unless changes in buyer's specifications warrant a difference in the quotation. As in the case of many movements which ultimately have benefited the human race, the answer to the question is education.

STARTLING changes in methods of doing business have developed during the past few years. Loose practices in industrial buying with a consequent demoralization of prices will not be tolerated today by many large companies, and the list constantly is growing. Purchasing agents in many instances now insist that the original bid represent the lowest selling price for the commodity. If the seller, for any reason, later tries to change the selling price, the buyer is likely to become suspicious, to feel that the first quotation exceeded the cost price plus a fair profit. Under the circumstances, the buyer is likely to place the order with a competing manufacturer whose first and only bid apparently carries the stamp of fairness.

IF ALL the members of an industry agree to such a plan, and at the same time the National Association of Purchasing Agents places its stamp of approval upon the principle, which seems altogether possible, the finger of suspicion will point heavily to the seller who tries to break the agreement. The feeling that he is trying to secure an excess price on the first bid may show quickly that breaking such agreements is not profitable.

Comings and Goings of Foundrymen

Men of the Industry, Whose Activities Are Making Foundry History

H. P. KREULEN, vice president and plant manager, Spring City Foundry Co., Waukesha, Wis., sails for Europe Oct. 23. Mr. Kreulen expects to spend several months in Europe and will be in Holland, the country of his birth, during Christmas and New Year season, returning to this country about the middle of January. Mr. Kreulen formerly was foundry expert for the Bethlehem Steel Corp., Bethlehem, Pa.

H. P. Kreulen

Frederick Henrich has been appointed vice president, Buffalo Cooperative Stove Co., Buffalo.

Robert L. Streeter, since 1920 vice president of the United States Aluminum Co., Pittsburgh, and general superintendent of fabricating plants, has resigned.

Harry J. Hater, vice president and general manager, Aluminum Industries, Inc., Cincinnati, has been made a member of the manufacturers' divisional committee of the National Standard Parts association.

Al. J. Moore, foundry superintendent, Giddings & Lewis Machine Tool Co., Fond du Lac, Wis. is on a leave of absence from that company and is enjoying a fishing trip along the coast of Florida. Mr. Moore expects to return to the Giddings & Lewis company in the near future.

George W. Davies, formerly assistant secretary and treasurer, Campbell, Wyant & Cannon Foundry Co., Muskegon Heights, Mich., has been made assistant to the president of the Lakey Foundry & Machine Co., Muskegon, Mich. Mr. Davies will have charge of general sales of the Lakey company.

Thomas W. H. Jeacock, president, Buffalo Bronze Die Cast Corp., Buffalo, also has become general manager of the plant. **Nathaniel W. Meloon,** formerly vice president and general manager, has been appointed director of research, **L. G. Smith,** formerly foundry foreman, has been named plant manager. **William Trankle** has been made foundry foreman to succeed Mr. Smith. **Robert A. Scott** has been elected secretary.

Albert E. Grover, for the past three years cost consultant, National Machine Tool Builders' association, has resumed independent cost consulting practice and will specialize in the foundry and machine shop field. He also will continue to serve the association in a consulting capacity. Mr. Grover started his cost accounting work with the Geneva Metal Wheel Co., Geneva, O., in 1904. Seven years later he was employed by the firm of Nau, Rusk and Swearingen, Cleveland, certified public accountants and during the eight years he was connected with that company he specialized in foundry work. He then became comptroller, Dunham Co., Berea, O., but in 1921 returned to the professional field, being employed as cost manager, Kohr, Brubaker & Fisher, Cleveland. A short time after that he established his own cost accounting practice and in 1928 formed the connection with the National Machine Tool Builders' association, where he undertook to standardize the cost finding methods in use in the shops of the members. Mr. Grover studied the methods in use, not only in the member plants, but in other machine shops as well, and from the information collected, prepared a series of bulletins which were laid before the industry for criticism and comment. Recently he has prepared this information in the form of a manual, which the officers of the association state represents a service not only to the machine tool builders but to the broad group of machinery building industries. Mr. Grover will maintain his headquarters at Berea, O.

Pennsylvania Pump & Compressor Co., Easton, Pa., recently formed a connection with Byer Engineering Associates, Easton, with branch offices at 136 Liberty street, New York and 1328 Chestnut street, Philadelphia. The Byer company specializes in direct contact condensing and cooling apparatus, barometric and low level jet condensers, reciprocating and steam jet vacuum pumps, etc.

Equipment Men Meet

The Foundry Equipment Manufacturers' association at its meeting held in Cleveland, Sept. 25, discussed the policy of group representation at the Century of Progress exposition in Chicago in 1933. After the presentation of a report by S. T. Johnston, chairman of the association committee, it was decided to cooperate with the American Foundrymen's association on any plans which may be formulated.

Albert E. Grover

E. H. Ballard, General Electric Co., West Lynn, Mass., president of the American Foundrymen's association, delivered the principal address of the meeting. He presented points for consideration from a foundryman's standpoint on what is expected of equipment designed for foundry service. Mr. Ballard suggested the adoption of the name *pressure cleaning* instead of sandblast as indicating the broader applications of this method of castings cleaning, inasmuch as metallic abrasives have made the older term a misnomer.

General business conditions in the equipment industry were discussed. President H. S. Simpson, National Engineering Co., Chicago, presided.

Contracts representing an investment of nearly $400,000 have been placed with the Austin Co., Cleveland, engineers and builders, recently.

OBITUARY

A. A. Grubb, member of the firm of Grubb & Marshall, metallurgical engineers, Columbus, O., died Sept. 29. Mr. Grubb was born at North Liberty, O., in 1891 and was graduated from the Johnstown, O. high school in 1909. He was graduated from Denison university in 1914 and received a M. A. degree in physics from Ohio State university in 1915. He was head of the department of physics and chemistry at Ashland College from 1915 to 1917. During the war he served in the science and research division of the U. S. signal corps and was an officer in charge of the meteorlogical section at Aberdeen proving grounds. From 1919 to 1928, Mr. Grubb was director of laboratories, Ohio Brass Co., Mansfield, O. In the latter year he went to the California Institute of Technology to undertake some research work on the sedimentation of colloids and also do consulting work on foundry sands. Later, he became a member of the firm of Grubb & Marshall. Mr. Grubb has done much to add to the research work on foundry sands and was a member of several A. F. A. committees on molding sand research. He was chairman of the committee on grading, member of the executive committee on tests and subcommittees on rebonding clay and on core tests. He also was a member of the subcommittee on foundry sands and on technical exhibits under the program and papers committee.

Thomas L. LaMalta, president of the Chickasaw Machinery and Foundry Co., Memphis, Tenn., died recently.

Clemuel R. Woodin, aged 86 years, father of William H. Woodin, president of the American Car & Foundry Co., and a director in the American Car company, died Friday at his home in Berwick, Pa. He was one of the nation's foremost railroad equipment builders.

Adam Kreuter, 70, vice president, director and general factory manager of the American Laundry Machinery Co., Chicago, died Sept. 26, at McHenry, Ill. He has been in the laundry machinery business for 45 years, and was supervising head of the five plants of the American Laundry Machinery Co.

Edward Chapman Fuller for many years prominently identified with the United States Cast Iron Pipe & Foundry Co., died at his home in Columbus, O., Sunday, Oct. 4, at the age of 78. Mr. Fuller was appointed assistant to the first vice president of the company in 1904 and later was made a director. In his capacity of pig iron buyer for a company which operates extensive foundries in Anniston, Bessemer and Birmingham, Ala; Burlington, N. J.; Cleveland and Addystone, O.; Chattanooga, Tenn.; and Scottdale, Pa., he was widely known to blast furnace operators who cater to the foundry trade. He retired from active business about 12 years ago.

Washington Balkwill, for many years associated with the Cleveland Steel Casting Co., died in Cleveland, Oct. 5, aged 82. Mr. Balkwill was born in London and served as a patternmaker apprentice before coming to this country as a young man. While working at the Bowler Foundry Co., Cleveland, he became acquainted with N. P. Bowler and together they organized the Cleveland Steel Casting Co. in 1892 and about the same time started the Standard Car Wheel Co., Cleveland. Sometime later Mr. Balkwill took over the management of the Cleveland Steel Casting Co. In partnership with George C. Lucas, he formed the Cleveland Frog & Crossing Co., Cleveland. Mr. Balkwill continued active in both companies for many years, retiring about 12 years ago and was succeeded by his son George W. Balkwill. He was a member of the National Founders ssociation, a charter member of the Steel Founders' Society of America and also a member of the American Iron & Steel institute.

Purchasing Agents To Show Products

As a stimulus to the somewhat more optimistic note in business, firms represented in the membership of the Purchasing Agents' association of New York will hold an exhibition of products in the roof gardent of the Pennsylvania hotel on Tuesday, Nov. 17. The exhibition, which is an innovation with the purchasing agents of the metropolitan district, will have more than 100 exhibitors in a wide range of products, machinery and service. No charge for space will be made but exhibit will be confined to firms represented in the membership of the association.

The exhibition will be held in conjunction with the November dinner meeting of Purchasing Agents association which will be presided over by H. T. Coates, purchasing agent of the Dairymen's League Co-operative association and president of the Purchasing Agents' group. The meeting will be addressed by one of the most prominent industrial leaders of the country.

Brass Founders Meet

The regular monthly meeting of the Associated Brass Founders of New England was held at the Engineers club, Boston, Wednesday, Sept. 23. W. J. Sweet and C. A. Crawford, International Nickel Co., New York, spoke on the "Application of Nickel in the Brass Foundry Industry." An interesting discussion of the subject followed the addresses.

Auto Industry Consumes Most Malleable

The automobile industry is the country's leading consumer of six basic industrial commodities, according to a bulletin of the American Research foundation which stresses the importance of the automobile to the economic stability of the United States. In the case of four of these commodities the automobile's share of consumption is shown to exceed one-half of the total annual production.

The country's motor vehicles, according to the bulletin, consume 85 per cent of all the gasoline produced in the United States, 82.6 per cent of all the rubber, 68.7 per cent of all the plate glass, 53 per cent of the malleable iron, 30 per cent of the nickel and 26 per cent of the lead. No other industry, it is stated, takes an equal share of any one of these products.

Company Reorganized

E. C. Stearns & Co., 224 Oneida street, Syracuse, N. Y., recently was reorganized. Boyd Dudley, formerly associated with the American Piano Co., Rochester, N. Y., has been elected president and general manager and J. E. Stearns, formerly manager, Globe Foundry & Forging Co., Syrauce, has been appointed vice president and treasurer. Edgar F. Brown is secretary, G. Gara, formerly with the Amphion Piano Co., factory superintendent, and Charles Kremin, also formerly associated with the Globe company, is foundry superintendent.

Test Core Oils

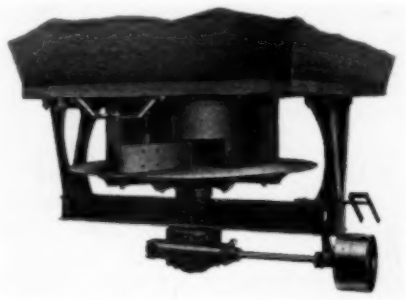
A study of core oils formed the subject of an investigation recently carried out by C. H. Casberg and C. E. Schubert at the University of Illinois, Urbana, Ill., and the results are published in bulletin No. 221 of the Engineering Experiment station. From data obtained the authors found that tensile strength of the cores is proportional to the saponification number and to the iodine number. The constants in the respective cases are 0.77 and 0.99. Percentage loss in tensile strength was found to be proportional to the amount of water absorbed while standing in the mold. Copies of the bulletin may be obtained for 15 cents.

The industrial sales department of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has been reorganized under the direction of O. F. Stroman, industrial sales manager. Bernard Lester and C. B. Stainback have been appointed assistant sales managers. The mining and metalworking electrification division will be under the direction of G. E. Stoltz, manager.

Measures Materials

A worm gear drive disk feeder for metering crushed and ground materials recently has been placed on the market by the Deister Concentrator Co., 901 Glasgow avenue, Ft. Wayne, Ind. As shown in the accompanying illustration, the outlet is made from steel plate rolled to size with angle flange for bolting to the underside of the bin. The renewable disk is a 60-inch steel circle made of heavy steel plate bolted to a gray iron spider. The spider is bored and keyed to the heavy vertical shaft.

The unit is driven through worm gearing which is accurately machined, equipped with ball thrust and roller bearings, runs in oil and is encased in a dust proof housing. The worm gear shaft is driven by tight and loose pulleys. Starting or stopping of the feeder can be arranged to work automatically with any other unit.



The Measuring Device Is Driven Through a Worm Gear

Discharge is controlled by the angle of the plow, which may be adjusted while the machine is in operation. The frame, step and outboard bearing are mounted on channels and supported on heavy legs or brackets. The feeder can be supported on its own foundation or suspended from the outside of the bin.

Radiator Plants Gain

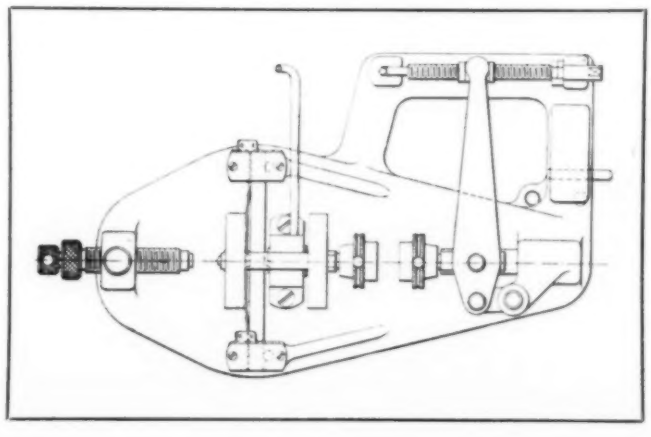
Foundry operations in the Pittsburgh district have shown little response to seasonal influences, the average rate being but slightly above the low level reached in August. A mild gain is noted in some directions since that time. Radiator foundries experienced a moderate increase in operations, but jobbing interests continue around a 20 per cent rate. Producers of heavy mill machinery remain well engaged except in roll production which still is sharply depressed.

Machine Tests Small Metal Sections

Tensometer Ltd., 73, Southampton row, London, W. C. 1, recently introduced a small testing machine which may be used to determine the tensile strength and brinell hardness of small sections trepanned from castings. The unit is portable and weighs 20 pounds. Trials carried out at the National physical laboratory show that the mechanism gives results within 2 per cent of those obtained on full sized test pieces.

Test pieces used are 0.1593 inch in diameter and the gage length is 0.6275 inch. To operate the machine the test piece is placed in an elongation gage which resembles a core box. The top half is provided with two points on the inside which mark off the gage length. The specimen is held in universally mounted chucks. Deflection of the beam is measured by displacement of a piston in a small mercury cylinder. The gage showing the deflection also is equipped to read the load in tons per square inch and the actual load on the specimen. The load is applied by a screw and lever mechanism attached to the tail piece of the machine. The rotation of the handle is easy and examination of the dimensions of the broken specimen is facilitated by the provision of gages which give direct readings.

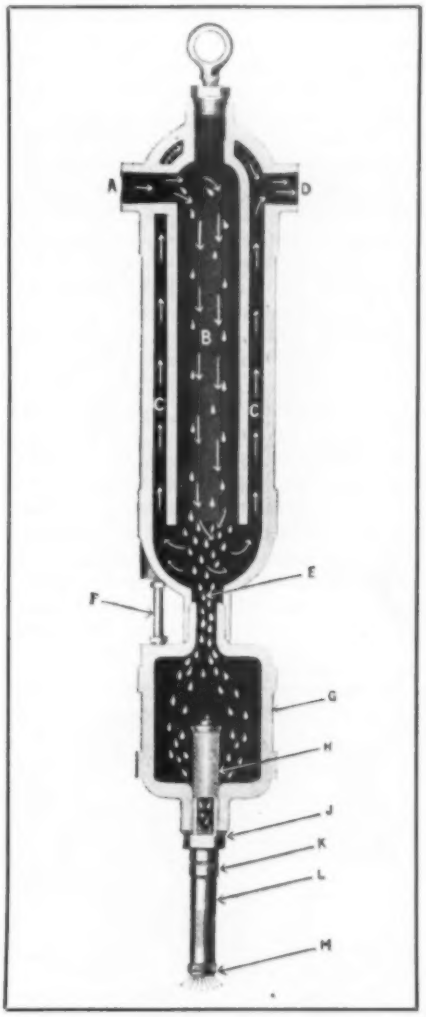
Another feature of the machine is a recorder which traces a stress-strain diagram by co-ordinating tons per square inch with turns of the handle. The apparatus shows the yield point and maximum strength. The brinell testing machine, which is included in the apparatus, is equipped to give a load of 1500 kilograms and a permanent scale is provided for direct reading of hardness numbers after the diameter of the impression has been ascertained.



Load Is Applied by a Screw and Lever Mechanism Attached to the Tail Piece of the Machine

Expands Air to Move Oil and Water

Leavitt Machine Co., Orange, Mass., has developed an automatic separator for removing oil and water from compressed air lines. The device consists of a receptacle which is vented to the atmosphere. As it receives the moisture it expels it immediately, allowing no opportunity for the air to pick it up again.



Water Separated in Chamber B is Removed Through G

The principle of operation is shown in the accompanying illustration. Air enters the separator at *A*, passes into the expansion chamber at *B*, which has an area nine times greater than the inlet *A*. This allows the air to expand and precipitate any oil or water into the eliminator *G*, from which it is expelled immediately through the vent *K*. The air rises to the outlet *D* through the expansion chamber *C*, which has a greater area than chamber *B*. This still further retards the flow.

Speed Features Jarr Rollover Machine

Herman Pneumatic Machine Co., Union Bank building, Pittsburgh, recently has introduced a new jarr, rollover, pattern drawing molding machine, which is designed to jarr, rollover and draw the pattern in less than one minute. The machine is built in three sizes, each having a rollover capacity of 750 pounds at 80 pounds air pressure. The turnover plate is made in the following sizes: 20 x 24 inches, 20 x 30 inches and 20 x 36 inches.

Rolling over and drawing the pattern is oil controlled and pattern drawing has an automatic feature for slow and fast drawing. The equalizer for taking up irregularities in flask bottom board is a spring alignment device with automatic air lock. The turnover plate is equipped with vibrators having an automatic starting device. One handle of a rotary valve controls the jarring, rolling over, drawing of the pattern, vibrator, equalizer lock, etc.

Pressure lubrication is provided to every moving part, with automatic lubrication included for such parts as the vibrator, jarring machine cylinder and control valve. The machine also has been designed to prevent sand and dirt from coming into contact with the moving parts. The jarring machine is of the impact type and has a built in mechanical foundation which is said to be shockless. The jarring machine and rollover device is assembled complete on a sub base and a simple, inexpensive foundation is used when installing the machine.

On the smaller size machine with the 20 x 24-inch turnover table, the jarring machine plate table is 14 x 18 inches, the maximum clearance between the uprights on the turnover plate is 32 inches, the maximum overall length of flasks is 31 inches and the maximum width of flasks is 30 inches. Four views of the machine showing the sequence of operations are shown in the accompanying illustrations.

Builds Type of Goggle for Welding

Linde Air Products Co., 30 East Forty-second street, New York, recently introduced a new type welders' goggle. The goggle is designed to fit the eyes and is adjustable to conform to the individual nose. The edge of the cup coming in contact with the face is shaped to conform to the general contour of the cheekbone and nose, and fits smoothly around the eyes. Eye-pieces are joined with a leather strap, adjusted by a metal buckle, so that they may be spaced correctly to the width of the face.

Ventilation ports on each side of the eye-cups are constructed so that it is impossible for sparks or light to reach the inside of the cup. The depth of the cup permits ample circulation of cool air. The field of vision has been increased by use of 50 millimeter diameter lenses instead of the usual 47 millimeter lenses. Brown color lenses are available as with older type goggles, and in addition, a new special quality green lens is available in three shades. Lenses may be changed easily by removing the metal cups which unscrew from the frames of

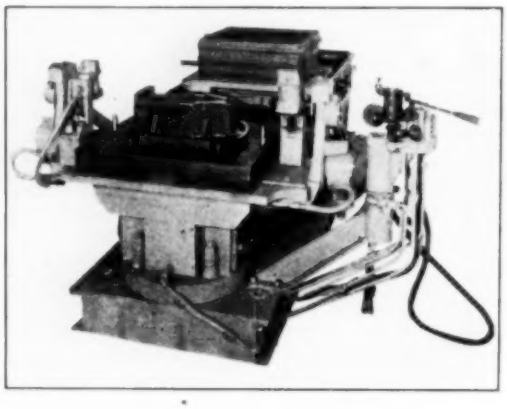
The material of which these goggles are made differs from that previously used.

Goggle Is Shaped To Fit Smoothly Around the Eyes

Visit Malleable Plant

The second meeting of the Fall season of the Malleable club, Milwaukee, was held Tuesday, Oct. 13, in Racine, Wis., following a visit of inspection to the plant of the Belle City Malleable Co.

The Malleable club will continue its affiliation with the department of metallurgy, University of Wisconsin, which was started a year ago. The technical discussions are under the leadership of Professor Scott Mackay, department of metallurgy, University of Wisconsin, and will be a feature of the meetings throughout the year.



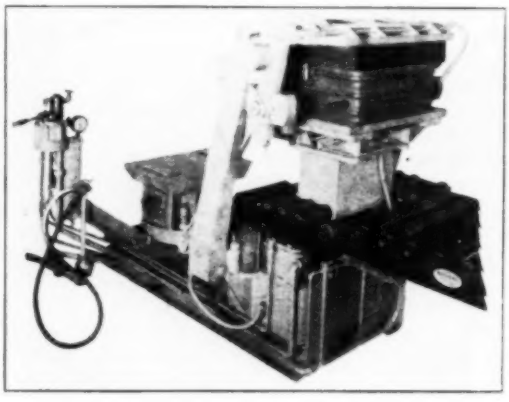
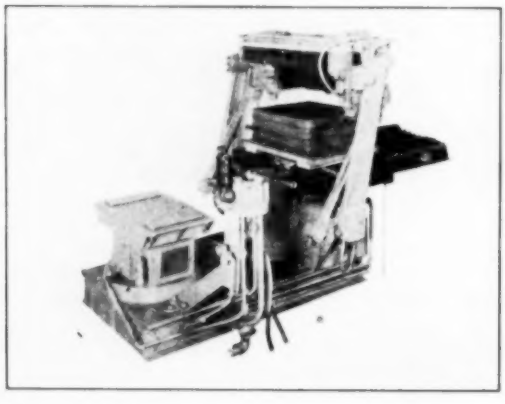


Fig. 1 (Left)—Front View of Machine With Pattern in Place. Fig. 2 (Right) Rolling Over the Mold With the Automatic Equalizing Device Against the Bottom of the Flask Ready To Draw the Pattern



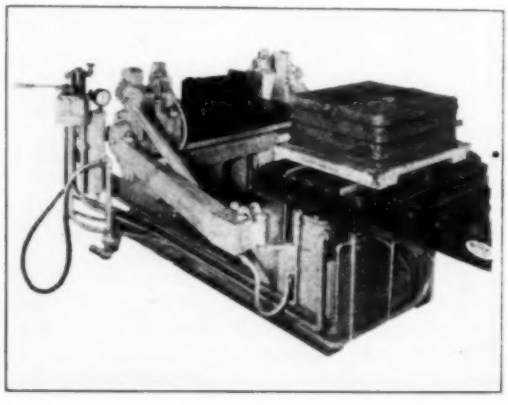


Fig. 3 (Left)—The Mold Being Lowered from the Pattern on the Automatic Equalizing Device. Fig. 4 (Right)—The Mold Resting on the Conveyors and the Arm Carrying the Pattern Returned to the Original Position

What the Foundries Are Doing

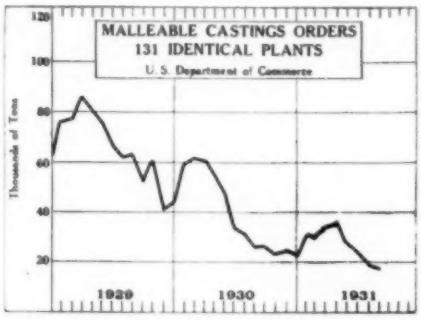
Reflecting the Activities of Gray Iron, Malleable, Steel and Brass Shops

Richardson & Boynton Co., Whitesboro, N. Y., is operating at approximately 65 per cent of capacity.

Utica Radiator Corp, 2201 Dwyer avenue, Utica, N. Y., is operating at approximately 70 per cent of capacity.

Eureka Brass Foundry, 1054 Cambridge street, Camden, N. J., is being operated by John S. Schwab.

Alloy Foundry & Machine Co., Toledo, O., has been incorporated with 500 no par shares by W. T. Walker and George N. Effler to take over the business of the Toledo Alloyed Castings Co.



The new foundry of the Frank Hamacheck Machine Co., Kewaunee, Wis., recently was completed.

Foundry and machine plant of the Covington Machine Co., Inc., Covington, Va., has been offered for sale by J. W. C. Johnson, Clifton Forge, Va., receiver.

Goodell-Pratt Co., Greenfield, Mass., and the Millers Falls Co., Millers Falls, Mass., have merged to effect economies of operation of the two companies.

Whitehead & Kales Co., 58 Haltiner street, River Rouge, Mich., is discontinuing its foundry and selling the plant equipment.

Utica Valve & Fixture Co., 304 Hubbell street, Utica, N. Y., has liquidated its business and closed its plant permanently.

Wadsworth Foundry Co., Wadsworth, O., has purchased a triangular piece of property between Auble Street and Erie railroad from the city.

Patterson Foundry & Machine Co., 1250 St. George street, East Liverpool, O., is constructing a $75,000 power plant to provide electricity for its three plants.

Almont Mfg. Co. Inc. has discontinued foundry operations at its Almont, Mich., plant and is centering the production of castings at its plant in Imlay City, Mich.

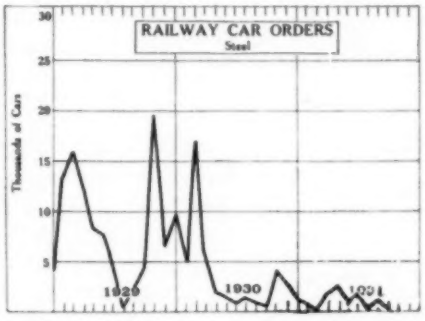
Standard Piston Rings Inc., Muskegon, Mich., has been incorporated with 5000 no par shares by K. Gudelsky, 1284 Ransom street, to conduct a general foundry business.

Armstrong Foundry & Machine Shop Ltd., Orangeville, Ont., whose incorporation recently was noted, is reported to be in the market for equipment to be installed in a proposed plant. Uriah W. Christie is manager. (Noted Oct. 1.)

An involuntary bankruptcy petition was filed in Federal Court, Pittsburgh, recently against the Allegheny Foundry & Machinery Co., Cheswick. The court of common pleas, of Pittsburgh, on Aug. 21 appointed a receiver for the company in an equity suit.

Vermilion Malleable Iron Co., Hoopeston, Ill., recently resumed operation with a force of approximately 150 men employed. The company is reported to have work on hand sufficient to operate for six months.

Columbus Ornamental Iron Co., 894 Michigan avenue, Columbus, O., has been formed by Howard P. Jennings, 1188 Westwood avenue, and associates, to design and manufacture ornamental iron.



L. J. Mueller Furnace Co., 197 Reed street, Milwaukee, recently resumed operation with approximately 200 employes. The plant will operate five and one-half days a week, with the possibility of increasing the schedule during the next few months.

Eddy Stoker Corp., 372 West Grand avenue, Chicago, recently organized, has started the manufacture and installing of underfeed stokers for automatic burning of coal in domestic boilers. Quarters have been leased in the R. M. Eddy Foundry Co. plant.

G. O. Eckstedt and associates, East St. Louis, Ill., have leased the building formerly occupied by the Howe Safety Appliance Co., Granite City, and will start operations for the manufacture of gray iron castings. Brass castings also may be produced.

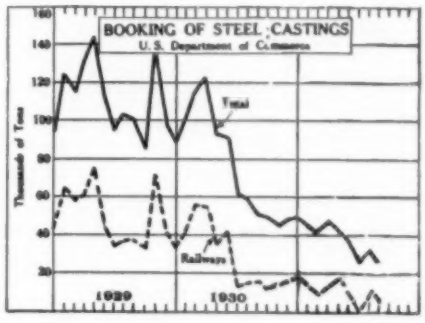
Posey county circuit court has granted permission to Ralph H. Staples and Lena B. Staples, joint administrators of the estate of the late John Staples, to continue the operation of the John Staples Foundry, Second and Railroad streets, Mt. Vernon, Ind.

Eriez Stove Mfg. Co., 1119 West Eighteenth street, Erie, Pa., has been placed in receivership. The plant is operating at approximately 30 per cent of capacity under the receivership. Disposal of the plant is uncertain as reorganization may be effected later. E. C. Gamble is general superintendent.

Michigan Valve & Foundry Co., which recently succeeded the Columbus Valve Co., 412 West Spruce street, Columbus, O., is to be a part of the new company announced recently and known as the Timken-Michigan Co., with R. J. Goldie, vice president and general manager of the Columbus firm, president of the newly formed organization.

Alaska Freezer Co., Lincoln street, Winchendon, Mass., is working 100 per cent of capacity and at present is employing more men than ever before in the history of the company. The company's prospects for continued operation at full capacity over a long period are bright. W. H. Meyer Jr. is general manager and F. L. Baker is works manager.

Malleable casting plants in the St. Louis territory specializing in automotive castings reported a moderate betterment in demand around the first of October. Stove foundries in that district are operating at higher schedules, several working full time with restricted forces. Shipments of stoves and furnaces in September compared favorable with the movement of those products a year ago.



Fulton Iron Works, St. Louis, has filed a petition in voluntary bankruptcy. The company has been in business for 80 years and has specialized largely in sugar machinery and engines. E. W. Kopke, president, stated in the petition that the company is not insolvent but could not meet maturing obligations and was threatened with suits by creditors.

Trade Publications

POWER FACTOR CORRECTION—Capacitors for power factor correction in electrical circuits are described in a recent illustrated bulletin from General Electric Co., Schenectady, N. Y.

FIRST AID MATERIALS—A catalog recently issued by Mine Safety Appliances Co., Braddock, Thomas & Meade streets, Pittsburgh, contains a complete listing of first aid supplies including bandages, splints, and tinctures adapted to industrial and general use. Description and illustrations of the items are included.

RECORDING INSTRUMENTS—C. J. Tagliabue Mfg. Co., Park and Nostrand avenues, Brooklyn, N. Y., has issued a new catalog of more than 100 pages describing its complete line of controllers, recorders, dials, thermometers, hydrometers, oil test instruments, and moisture meters. Many applications of the instruments are listed. A pictorial story is presented of the company's products in manufacturing processes.

WHERE-TO-BUY

A classified list of advertisers according to products. ¶Index to advertisements give page number of any advertiser.

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American Steel Abrasives Co., Galion, O.
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Philadelphia Steel Abrasive Co., The, East of Lewis & Ashland Sts., Frankford, Philadelphia, Pa.
Pittsburgh Crushed Steel Co., Pittsburgh, Pa.
Steel Shot & Grit Co., Amesbury, Mass.
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Linde Air Products Co., 30 E. 42nd St., New York City.

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ARC WELDING EQUIPMENT

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ARCHITECTS—Industrial

Austin Co., The, 16112 Euclid Ave., Cleveland, O.

ARRESTORS & COLLECTORS—Dust—See Dust Arresting and Collecting Systems

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Ajax Metal Co., 46 Richmond St., Philadelphia, Pa.

BARS (Steel)

Bethlehem Steel Co., Bethlehem, Pa.

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Osborn Mfg. Co., Inc., 5401 Hamilton Ave., Cleveland, O.

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Truscon Steel Co. (Pressed Steel Div.) 6100 Truscon Ave., Cleveland, O.

BRIDGES & BUILDINGS—Steel

American Bridge Co., Frick Bldg., Pittsburgh, Pa.

BRONZE—Manganese

Ajax Metal Co., 46 Richmond St., Philadelphia, Pa.

BRUSHES—Foundry

Osborn Mfg. Co., Inc., 5401 Hamilton Ave., Cleveland, O.

BRUSHES—Motor and Generator

General Electric Co., Schenectady, N. Y.
United States Graphite Co., The, Saginaw, Mich.

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Milwaukee Electric Crane & Hoist Corp., Milwaukee, Wis.

BUCKETS

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Brosius, Edgar E., Inc., 19th St. & P. R. R., Sharpsburg P. O., Pittsburgh, Pa.
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Electro Metallurgical Sales Corp., 30 E. 42nd St., New York City.

CALCIUM CARBIDE

Linde Air Products Co., 30 E. 42nd St., New York City.

CALKING HAMMERS—Pneumatic

Independent Pneumatic Tool Co., 600 W. Jackson Blvd., Chicago, Ill.

CARBIC

Linde Air Products Co., 30 E. 42nd St., New York City.

CARBIDE

Linde Air Products Co., 30 E. 42nd St., New York City.

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Foundry Equipment Co., The, 1831 Columbus Rd., Cleveland, O.
General Electric Co., Schenectady, N. Y.
Penn Foundry & Mfg. Co., Reading, Pa.

CARS & LOCOMOTIVES—Industrial

Industrial Equipment Co., The, Minster, O.

CASTINGS (Gray Iron)

Bethlehem Steel Co., Bethlehem, Pa.

CASTINGS (Heat Resistant)

Driver-Harris Co., Harrison, N. J.

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Driver-Harris Co., Harrison, N. J.

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Electro Metallurgical Sales Corp., 30 E. 42nd St., New York City.

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Hanna Furnace Corp., The, Detroit, Mich.

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Bartlett, C. O., & Snow Co., 6201 Harvard Ave., Cleveland, O.

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Bartlett, C. O., & Snow Co., 6201 Harvard Ave., Cleveland, O.
Harnischfeger Corp., 3800 National Ave., Milwaukee, Wis.
Louden Machinery Co., 183 Court St., Fairfield, Iowa.
Milwaukee Electric Crane & Hoist Corp., Milwaukee, Wis.

COKE

Bethlehem Steel Co., Bethlehem, Pa.
Hanna Furnace Corp., The, Detroit, Mich.
Semet-Solvay Co., 61 Broadway, New York City.

CONVEYERS—Belt

Bartlett, C. O., & Snow Co., 6201 Harvard Ave., Cleveland, O.

CONVEYORS—Monorail

Louden Machinery Co., 183 Court St., Fairfield, Iowa.

CONVEYING AND ELEVATING EQUIPMENT

Arcade Mfg. Co., Dept. D., Freeport, Ill.
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Cleveland Electric Tramrail Div. of Cleveland Crane & Eng. Co., Wickliffe, O.
Louden Machinery Co., 183 Court St., Fairfield, Iowa.
National Engineering Co., 549 W. Washington Blvd., Chicago.
Osborn Mfg. Co., Inc., 5401 Hamilton Ave., Cleveland, O.

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Corn Products Refining Co., 17 Battery Place., New York City.
Pennsylvania Lubricating Co., 34th & Smallman Sts., Pittsburgh.
Smith, Werner G., Co., 2191 W. 110th St., Cleveland, O.

CORE BREAKERS

Bartlett, C. O., & Snow Co., 6201 Harvard Ave., Cleveland, O.

CORE COMPOUNDS

Corn Products Refining Co., 17 Battery Place, New York City.
Lindsay-McMillan Co., 930 S. Water St., Milwaukee, Wis.
Pennsylvania Lubricating Co., 34th & Smallman Sts., Pittsburgh.
Smith, Werner G., Co., 2191 W. 110th St., Cleveland, O.

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Arcade Mfg. Co., Dept. D, Freeport, Ill.
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Osborn Mfg. Co., Inc., 5401 Hamilton Ave., Cleveland, O.
Tabor Mfg. Co., The, 6225 Tacony St., Philadelphia, Pa.

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Lindsay-McMillan Co., 930 S. Water St., Milwaukee, Wis.
Pennsylvania Lubricating Co., 34th & Smallman Sts., Pittsburgh.
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CORE RACKS

Foundry Equipment Co., The, 1831 Columbus Rd., Cleveland, O.
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CORE RODS

Franklin Core Rod & Gagger Co., Franklin, Pa.

CORE ROOM EQUIPMENT

Truscon Steel Co. (Pressed Steel Div.) 6100 Truscon Ave., Cleveland, O.

CORE SAND MIXERS

National Engineering Co., 549 W. Washington Blvd., Chicago, Ill.